PROCEEDINGS

OF THE

# AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA FOR PROMOTING USEFUL KNOWLEDGE.

VOL. XXXIII. JANUARY, 1894. No. 144.

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☞ It is requested that the receipt of this number be acknowledged.

☞ In order to secure prompt attention it is requested that all correspondence be addressed simply "To the Secretaries of the American Philosophical Society, 104 S. Fifth St., Philadelphia."

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# EXTRACT FROM THE LAWS.

## CHAPTER XII.

### OF THE MAGELLANIC FUND.

SECTION 1. John Hyacinth de Magellan, in London, having in the year 1786 offered to the Society, as a donation, the sum of two hundred guineas, to be by them vested in a secure and permanent fund, to the end that the interest arising therefrom should be annually disposed of in premiums, to be adjudged by them to the author of the best discovery, or most useful invention, relating to Navigation, Astronomy, or Natural Philosophy (mere natural history only excepted); and the Society having accepted of the above donation, they hereby publish the conditions, prescribed by the donor and agreed to by the Society, upon which the said annual premiums will be awarded.

### CONDITIONS OF THE MAGELLANIC PREMIUM.

1. The candidate shall send his discovery, invention or improvement, addressed to the President, or one of the Vice-Presidents of the Society, free of postage or other charges; and shall distinguish his performance by some motto, device, or other signature, at his pleasure. Together with his discovery, invention, or improvement, he shall also send a sealed letter containing the same motto, device, or signature, and subscribed with the real name and place of residence of the author.

2. Persons of any nation, sect or denomination whatever, shall be admitted as candidates for this premium.

3. No discovery, invention or improvement shall be entitled to this premium, which hath been already published, or for which the author hath been publicly rewarded elsewhere.

4. The candidate shall communicate his discovery, invention or improvement, either in the English, French, German, or Latin language.

5. All such communications shall be publicly read or exhibited to the Society at some stated meeting, not less than one month previous to the day of adjudication, and shall at all times be open to the inspection of such members as shall desire it. But no member shall carry home with

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*January 5, 1894.*

The annual election for Officers and Councilors was held this afternoon between the hours of 2 and 5 P.M. The result was submitted to the Society at the evening meeting by the officers of the election.

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*Stated Meeting, January 5, 1894.*

President, Mr. FRALEY, in the Chair.

Prof. W. H. Appleton, a lately elected member, was presented and took his seat.

Correspondence was submitted as follows:

A circular was received from the Nederlandsche Maatschappij ter bevordering van Nijverheid, Harlem, offering a prize for 1894.

Accessions to the Library were reported from the Australasian Association for the Advancement of Science, Sydney; Institut Egyptien, Cairo, Egypt; Anthropological Society, Tokyo, Japan; Friesch. Genootschap van Geschied, etc., Leuwarden; Société R. de Géographie, Antwerp, Belgium; Société Hongroise de Géographie, Budapest; Siebenbürgische Verein

für Naturwissenschaften, Hermanstadt, Transylvania; Physiologische Gesellschaft, Messrs. R. Friedländer und Sohn, Berlin, Prussia; Verein für Erdkunde, K. Sächs. Alterthums-Verein, Dresden, Saxony; K. Leopoldinisch-Carolinische Deutsche Akademie der Naturforscher, Halle a. S., Prussia; Deutsche Seewarte, Hamburg, Germany; K. Sächs. Gesellschaft der Wissenchaften, Leipzig; K. B. Akademie der Wissenschaften, Munich, Bavaria; Society of Arts, Royal Astronomical Society, Editors of *Nature*, Royal Society, Meteorological Society, Prof. Joseph Prestwich, London, Eng.; Literary and Philosophical Society, New Castle-upon-Tyne, Eng.; Geological Survey of Canada, Ottawa; Bureau of Statistics of Labor, Athenæum, The family of the late John Pickering, Boston, Mass.; Harvard College, Mr. A. McFarland Davis, Cambridge, Mass.; American Antiquarian Society, Worcester, Mass.; The Travelers Insurance Company, Hartford, Conn.; Editor of the *Archæological Magazine*, Meriden, Conn.; Yale University, Editors of *American Journal of Science*, New Haven, Conn.; American Institute of Electrical Engineers, Mathematical Society, Meteorological Observatory, Editor of the *Popular Science Monthly*, Prof. J. A. Allen, New York, N. Y.; Free Public Library, Jersey City, N. J.; Geological Survey of New Jersey, Trenton; American Chemical Society, Easton, Pa.; Editors of the *Medical News*, College of Pharmacy, University of Pennsylvania, Messrs. Julius F. Sachse, Henry Phillips, Jr., Philadelphia; Editor of the *American Chemical Journal*, Baltimore, Md.; U. S. Geological Survey, Hydrographic Office, Commissioner of Labor, Bureau of Statistics, Washington, D.C.; State Board of Health, Nashville, Tenn.; Academy of Science, St. Louis, Mo.; Geological Publishing Company, Minneapolis, Minn.; Kansas Academy of Science, Topeka, Kans.; Academy of Science, Tacoma, Wash.; Agricultural Experiment Stations, Pennsylvania State College, Knoxville, Tenn., Madison, Wis, Laramie, Wyo; Sociedad Cientifica "Antonio Alzate," Observatorio Astronomico Nacional de Tacubaya, Mexico, Mex.; Société Scientifique du Chili, Santiago.

Photographs for the Society's Album were received of Messrs. R. Meade Bache and Thomas M. Cleemann.

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The following deaths were announced:

George de Benneville Keim, Philadelphia, December 18, 1893, æt. 64.

Dr. Charles M. Cresson, Philadelphia, December 27, 1893, æt. 66.

Dr. Dionys Stuer, Vienna, October 9, 1893.

The President having been authorized to appoint suitable persons to prepare the usual obituary notices, subsequently appointed Dr. Daniel G. Brinton for Mr. Keim.

The officers of the election held this afternoon pursuant to the laws of the Society reported the following members had been elected as Officers and Council of the Society for the ensuing year.:

*President.*

Frederick Fraley.

*Vice-Presidents.*

E. Otis Kendall, W. S. W. Ruschenberger, J. P. Lesley.

*Secretaries.*

George F. Barker, Daniel G. Brinton, Henry Phillips, Jr., George H. Horn.

*Curators.*

Patterson DuBois, J. Cheston Morris, R. Meade Bache.

*Treasurer.*

J. Sergeant Price.

*Councilors for Three Years.*

William P. Tatham, George R. Morehouse, Samuel Wagner, William C. Cattell.

*Councilor for Two Years, in place of Thomas H. Dudley, deceased.*

Henry Hartshorne.

Mr. Henry Phillips, Jr., was renominated for Librarian, and the nominations were closed.

Dr. Daniel G. Brinton read a paper on "Nagualism."

Mr. Lyman read a paper on "The Age of the Newark Brownstone."

Dr. Cope presented a communication on the fishes of Rio Grande do Sul.

Pending nominations Nos. 1268, 1269, 1270, 1271, 1272, 1273, 1274 were read.

The report of the Finance Committee was presented and the appropriations for the year were passed.

The Michaux Committee presented the following report and resolution, which were adopted:

The Michaux Committee of the American Philosophical Society respectfully reports, that at a meeting held on December 14, 1893, a letter was received from Dr. J. T. Rothrock enclosing list of the time and subjects proposed for the Fifteenth Course of Lectures for 1894, given under the auspices of the American Philosophical Society:

MONDAY EVENINGS.

Jan. 22. Pennsylvania Forests and Forest Trees (illustrated).
" 29. Protection of Pennsylvania Forests.
Feb. 5. Waste of Pennsylvania Forests (illustrated).
" 12. Possibilities of Forest Restoration.
" 19. Legal Relations of our Forests.
" 26. Trees in Cities and Towns (illustrated).
March 5. Waste Lands of the Commonwealth (illustrated).

The Lectures will be delivered in the Pennsylvania University Building, which has been kindly tendered to him for the purpose. He estimates the cost of the lectures at $240.

The Committee approved of Dr. Rothrock's proposition, and asks for the passage by the Society of the following resolution :

"*Resolved,* That the sum of two hundred and forty dollars be appropri-

ated out of the income of the Michaux Fund for the expenses of the Fifteenth Course of the Michaux Forestry Lectures by Prof. J. T. Rothrock."

By order of the Committee,

J. Sergeant Price, *Secretary.*

The Librarian reported that Dr. Elliott Coues had returned personally all the Lewis and Clarke manuscripts borrowed by him ; that the same were correct in number and condition; that Dr. Coues had arranged them in a most excellent and careful manner, so as to facilitate all future reference ; in fact, that they were in much better condition than when loaned by the Society.

The Treasurer was authorized to receive from the city of Philadelphia the sum of $3000 due January 1, 1894, and to sign proper quittances therefor.

And the Society was adjourned by the President.

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## *Age of the Newark Brownstone.*

*By Benj. Smith Lyman.*

*(Read before the American Philosophical Society, January 5, 1894.)*

There seems to be reasonable ground for doubt whether the rock beds of the Newark, N. J., brown building stone quarries belong even to the Mesozoic, as they have generally been thought to. In spite of the unfavorable character of the sandstone for preserving fossils, it has yielded a number of specimens, and the identification of at least two species has been attempted. In the *New Jersey State Geological Report* for 1879, p. 26, the late deeply lamented State Geologist, Prof. Cook, speaks of certain fossils at the closely adjacent Belleville quarries, evidently in the same sandy beds, as follows, citing the unexcelled authority of Lesquereux :

"At the Belleville quarries thin seams of coal and impressions of the stems and branches of plants are not uncommon. A fragment of the stem of a plant with surface markings like the Lepidodendron was found, and is now the property of Mr. David Hitchcock, of Orange. It is a very plainly marked, flattened stem, eight inches long, four and one-half inches wide, and one and one-half inches thick. Photographs of this

were taken and sent to Prof. L. Lesquereux, of Columbus, Ohio. He returns the following answer:

"'The photographs are sufficient, if not for specific determination, at least for positive reference of the specimens to Lepidodendron. Even I should say that the specimens represent *L. weltheimianum* Presl as distinctly as a specific representation can be made upon a decorticated trunk of Lepidodendron. *L. weltheimianum* is a leading species of the old red sandstone found here, as in Europe, from the subcarboniferous measures down to the Devonian, while until now we do not have any remains of Lepidodendron of any kind from the upper coal measures (Permo-carboniferous), or from higher up than the Pittsburg coal.

"'*L. weltheimianum* is recorded only once from the true coal measures; this by Eichwald, from the Carboniferous sandstone of Russia. But European authors, among others Goeppert, doubt the identity of the Russian species with *L. weltheimianum*, which is moreover extremely variable, and has been described already under about thirty different names.'

"Another fragment [Prof. Cook adds] has since been obtained from the same quarries by Dr. Skinner, of Belleville, and is now in our possession. It is seven inches long, five and one-half inches wide, and one and one-half inches thick, and is as plainly marked as the first. Other and smaller specimens somewhat like the above have also been found in the quarries in Newark. If these fossils are sufficient to determine the geological age of these beds, they put it in the upper Carboniferous, at least, which is lower than has heretofore been claimed for it. A larger and more complete collection of such fossils must be made if possible.

"Vegetable impressions are found in large numbers at the quarries of Mr. Smith Clark, of Milford, but most of them are fragmentary and indistinct. Those which can be seen plainly enough for identification resemble the Equisetum and some coniferous plants. They are evidently much newer than the fossils at Newark and Belleville."

It is not to be wondered at that the very sagacious Prof. Cook should have perceived this great difference in age on even so cursory an examination; for the Newark brownstone is at least some nine thousand feet lower geologically than the Milford beds, a part of the Perkasie shales of Pennsylvania. Few species indicating the geological age have been reported from the Milford beds; but from the horizon of the Gwynedd and Phœnixville dark shales, far below those of Milford, and quite above the Newark beds, appear to have come most of the fossils in Pennsylvania, Virginia, North Carolina, and elsewhere, that have been thought to indicate the Rhætic age of all the older Mesozoic rocks of those States.

So fixed has become the impression of the Mesozoic age of all the beds that have hitherto commonly been grouped together under the name of the American New Red, and many other names, that it may even possibly have caused some bias in the minds of paleontologists in their determination of more or less doubtful fossils; though Lesquereux seems not to have been fettered by such a prejudice to the extent of blindness to otherwise

clear indications. Prof. William M. Fontaine may have been guided by equally clear indications, but his expressed argument does not seem perfectly sound when he says of a "New Red" fossil described and figured by Emmons as a Lepidodendron, and without pointing out what else it is: "These impressions are, of course, not those of Lepidodendron, as this plant does not exist in the Mesozoic." That would decidedly seem to be begging the question as to the age of the fossil. Newberry appears also to have been possibly influenced by the same assumption.

In has, in fact, been generally, but perhaps too superficially, assumed from the predominance mainly of a red color, and the absence of notable unconformities in the beds of the so-called New Red, and the lack of numerous convenient fossil indications, that the beds all belonged to one formation of no wide paleontological range, and consequently of no very great thickness. Now that our Pennsylvania investigations prove beyond a doubt that the total thickness is at least some twenty-seven thousand feet, the presumption is rather that the beds should be of very diverse geological age; and even it should not seem surprising if the lower ones, including the Newark brownstone, should prove to be of Paleozoic age.

Lesquereux's very positive, unhesitating recognition of the Lepidodendron would of itself make it highly probable that the brownstone was at least as old as the Carboniferous; and somewhat confirmatory wholly independent fossil evidence has been found in Pennsylvania. Several years ago Mr. S. E. Paschall, of Doylestown, pointed out to Prof. Henry Carvill Lewis certain calamite fossils that had been found by Mr. John S. Ash half a dozen miles easterly from Doylestown, just north of the old Paleozoic island, so to speak, and within the limits of the supposed Mesozoic, and now known to be a couple of thousand feet geologically below the brownstone beds. Lewis thought the calamite might be of Permian age. With much search Mr. Ash succeeded in finding a specimen that contained two joints with the whole internode, some twelve or fifteen inches long, and some eight inches or more broad, and it was sent to Lesquereux for identification. Other affairs through the short remainder of his busy life prevented Lesquereux from communicating any result of his examination, and the specimen has not yet been recovered. But Mr. Paschall has a less perfect fragment ten inches long, indicating a calamite of at least six inches in breadth, with a single joint at two inches from one end. He says there are other better specimens at the Academy of Natural Sciences.

The only two recorded fossils, both plants, that have been supposed to be identified beyond doubt, from the Newark quarries, are the *Dioönites longifolius* and *Clathropteris platyphylla*, mentioned by Newberry in his Monograph xiv, of the *U. S. Geological Survey*, on "The Fossil Fishes and Fossil Plants of the Triassic Rocks," etc., 1888, pp. 92 and 94. Fontaine speaks of the *Dioönites longifolius* among the North Carolina fossils, *U. S. Geological Survey*, Monograph vi, 1883, p. 111, judging merely by a description and figure of Emmons', as probably nearly allied to *Zamites*

*proximus* from the Rajmahal group of India (Jurassic); and in describing the *Clathropteris platyphylla* from the Virginia coal measures (probably corresponding in age to the Gwynedd and Phœnixville shales, and decidedly later than the Newark beds) points out (p. 56) several differences between it and the European Jurassic plant, with which, on the whole, he thinks it should be associated. Newberry (Monograph xiv, p. 94) says that fragments of the *Clathropteris platyphylla* have been obtained, though only rarely, from the beds of Newark; but the one he figures is from Milford, N. J., that is, some nine thousand feet above the Newark beds.

Newberry mentions (p. 86) also an imperfect Newark fossil that, "in reviewing the literature of the Triassic flora" (an expression that seems to show his inclination to assume *a priori* that the Newark beds were necessarily Mesozoic), he found to resemble the *Equisetum meriani*; but he candidly adds: "Until the fructification of these Equisetoid plants shall be found which will permit a better comparison with those of older and later formations, it is a useless expenditure of time to discuss the question whether they are species of *Calamites* which have survived from the Carboniferous age, are true *Equiseta*, or are species of an extinct genus of that family."

Newberry further speaks of a fossil tree trunk found frequently in the sandstone quarries of Newark, resembling *Lepidodendron*, adding in regard to the idea of its being one: "This is a manifest error. *Lepidodendron* did not pass from the Carboniferous to the Mesozoic age." Evidently he took it in advance for granted that the beds of Newark could not be older than Mesozoic. It is not unlikely these very fossils are of the species so readily identified by Lesquereux with the *Lepidodendron*. Newberry thinks they are probably a *Palissya*; and Fontaine mentions *Palissya indica*, a plant of the Rajmahal group, as occurring in North Carolina.

Apparently no other fossils have been recorded as coming from Newark; and it is seen that only two of them have been identified with any approach to certainty. Moreover, neither of the two would seem to be so closely like the nearest European and Indian forms as altogether to preclude the possibility of their being of very different age from them, especially considering their geographical remoteness.

Rogers, in his *Final Report on the Geology of Pennsylvania*, 1858, Vol. ii, p. 507, suggests the possibility of finding Permian fossils among the highest rocks of Greene county, in the southwestern corner of the State; and Stevenson, in his *Report of the Second Geological Survey of Pennsylvania*, 1876, shows (p. 35) that the highest known rocks there are red shales. Whether Carboniferous or Permian, it is by no means inconceivable that they may prove to be contemporaneous with the Newark beds.

The Canadian geologists have found that much of the formerly so-called Trias of Prince Edward Island, New Brunswick and Nova Scotia is really Permian, Permo carboniferous, or even Carboniferous (see the *Canada Geological Survey Reports*: Ells, 1882–84, 1885; Fletcher, 1886,

1890–91). Their description of the rock-beds shows a good deal of resemblance to those of Newark. Fletcher, in his last report, gives several detailed sections of Permian rocks up to five thousand and eight thousand feet in thickness. It seems hardly probable that no traces of so vast a formation should be found in the eastern United States near either the Mesozoic or Paleozoic rocks with which it is so intimately associated in Nova Scotia and Prince Edward Island.

It would seem, then, that the Mesozoic age of the beds of Newark is not so thoroughly certain but that it might be worth while for paleontologists to reëxamine with renewed care the indications of the fossils that really bear on the point. For undoubtedly the very scanty and imperfect testimony of the fossils already known; the apparent bias, on the one hand, in favor of comparing them only with Mesozoic forms that are extremely remote at best; on the other hand, the less biased partial identification of some Newark fossils with Paleozoic ones under conditions at least equally favorable as regards skill and material; the great thickness of measures below the comparatively well-identified Rhætic or Triassic horizon of the Gwynedd and Phœnixville shales, the same probably as the Richmond and North Carolina coal-bearing beds; and the possibility, to say the least, that some of the red beds conformably at the top of the Carboniferous rocks of southwestern Pennsylvania and of West Virginia, as well as some of the Permian or Carboniferous beds of eastern Canada, may be of identical age with the Newark beds; all these circumstances make it seem not altogether improbable that the Newark brownstone is older than the Mesozoic.

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## *Further on the Age of the Newark Brownstone.*

*By Benjamin Smith Lyman.*

(*Read before the American Philosophical Society, January 19, 1894.*)

An additional reason for doubting the Mesozoic age of the Newark brownstone may be found in the remarks of Newberry on his fossil plant *Dendrophycus triassicus*, found at Portland, Conn., in sandstone of possibly the same age as the Newark brownstone. He quotes (Monograph xiv, p. 82) Lesquereux's description of *Dendrophycus Desori*, found in the Pennsylvania No. XI, or Umbral shales; and adds: "I have copied this description nearly entire because it is almost literally applicable to a plant represented on Pl. xxi of this memoir and obtained from the sandstones of Portland, Conn. When we consider the vast interval of time between the deposition of the Umbral shale of Pennsylvania and that of the Rhætic sandstone of Connecticut, one the base of the Carboniferous sys-

tem and the other the summit of the Trias, it cannot fail to be regarded as interesting and surprising that the resemblance should be so complete. But for the *a priori* improbability that a species of seaweed should be so long-lived I should hardly feel justified in giving even a new specific name to the Triassic specimens. Possibly a comparison of more material would show differences not now perceptible, but the peculiar mode of growth and the details of structure seem to be essentially the same. In the Portland sandstones, as in the Umbral shales, the fronds of Dendrophycus are enrolled in masses that suggest cabbage heads of large size and rather loose texture, while the mode of subdivision and the character of the final ramifications of the fronds are so like that, with the similarity of the enclosing rock, the specimens from the two localities and horizons are almost undistinguishable."

It seems clear that the Portland *Dendrophycus*, if viewed without prejudice, would, like the Belleville and Newark *Lepidodendron*, strongly indicate the Paleozoic age of the brownstone.

It is not yet certain, however, whether the Portland sandstone and the Newark brownstone are of the same age; for the Portland beds are near the eastern edge of the so called Mesozoic rocks of Connecticut that have generally easterly dips, so that the beds have sometimes been taken to be near the top of the column, while the Newark beds are no doubt towards the bottom of the so-called Mesozoic of New Jersey. Still the geological structure in Connecticut has not been so thoroughly worked out as to make that position of the Portland beds perfectly sure. Percival's map would seem rather to indicate that they are on the eastern side of a basin; and Dana (*Am. Jour. Sci.*, 1891, Vol. xlii, p. 446) says the sandstone at Portland is nearly horizontal, and occasionally the dip is westerly. It seems, then, not impossible that some of the lower, more ancient beds have here come to the surface. It is not yet known, either, how great may be the total thickness of the Connecticut Mesozoic, so-called; nor to what parts of the New Jersey and Pennsylvania rocks it may correspond. But the lithological character, as well as the decidedly Paleozoic look of the only determined fossil of the Portland beds, go somewhat strongly to show an identity in age with the Newark brownstone.

At any rate the paleontological argument for the Mesozoic age of all parts of the so-called New Red is plainly not so perfect as it has often been supposed to be.

# *Nagualism. A Study in Native American Folk-lore and History.*

*By Daniel G. Brinton, M.D.*

(*Read before the American Philosophical Society, Jan'y 5, 1894.*)

CONTENTS.

**1.** The words, a *nagual*, *nagualism*, a *nagualist*, have been current in English prose for more than seventy years; they are found during that time in a variety of books published in England and the United States,* yet are not to be discovered in any dictionary of the English language; nor has *Nagualism* a place in any of the numerous encyclopædias or "Conversation Lexicons," in English, French, German or Spanish.

This is not owing to its lack of importance, since for two hundred years past, as I shall show, it has been recognized as a cult, no less powerful than mysterious, which united many and diverse tribes of Mexico and Central America into organized opposition against the government and the religion which had been introduced from Europe; whose members had acquired and were bound together by strange faculties and an occult learning, which placed them on a par with the famed thaumaturgists and theodidacts of the Old World; and which preserved even into our own days the thoughts and forms of a long suppressed ritual.

In several previous publications I have referred briefly to this secret sodality and its aims,† and now believe it worth while to collect my scattered notes and present all that I have found of value about the origin, aims and significance of this Eleusinian Mystery of America. I shall trace its geographical extension and endeavor to discover what its secret influence really was and is.

**2.** The earliest description I find of its particular rites is that which the historian Herrera gives, as they prevailed in 1530, in the province of Cerquin, in the mountainous parts of Honduras. It is as follows:

"The Devil was accustomed to deceive these natives by appearing to them in the form of a lion, tiger, coyote, lizard, snake, bird, or other animal. To these appearances they apply the name *Naguales*, which is as much as to say, guardians or companions; and when such an animal dies, so does the Indian to whom it was assigned. The way such an alliance was formed was thus: The Indian repaired to some very retired spot

* These words occur a number of times in the English translation, published at London in 1822, of Dr. Paul Felix Cabrera's *Teatro Critico Americano*. The form *nagual* instead of *nahual*, or *naual*, or *naual* has been generally adopted and should be preferred.

† For instance, in "The Names of the Gods in the Kiche Myths," pp. 21, 22, in *Proceedings of the American Philosophical Society*, 1881; *Annals of the Cakchiquels*, Introduction, p. 46; *Essays of an Americanist*, p. 170, etc.

and there appealed to the streams, rocks and trees around him, and weeping, implored for himself the favors they had conferred on his ancestors. He then sacrificed a dog or a fowl, and drew blood from his tongue, or his ears, or other parts of his body, and turned to sleep. Either in his dreams or half awake, he would see some one of those animals or birds above mentioned, who would say to him, 'On such a day go hunting and the first animal or bird you see will be my form, and I shall remain your companion and *Nagual* for all time.' Thus their friendship became so close that when one died so did the other; and without such a *Nagual* the natives believe no one can become rich or powerful."*

This province of Cerquin appears to have been peopled by a tribe which belonged to the great Mayan stock, akin to those which occupied most of the area of what is now Yucatan, Tabasco, Chiapas and Guatemala.† I shall say something later about the legendary enchantress whom their traditions recalled as the teacher of their ancestors and the founder of their nation. What I would now call attention to is the fact that in none of the dialects of the specifically Mexican or Aztecan stock of languages do we find the word *nagual* in the sense in which it is employed in the above extract, and this is strong evidence that the origin of Nagualism is not to be sought in that stock.

**3.** We do find, however, in the Nahuatl language, which is the proper name of the Aztecan, a number of derivatives from the same root, *na*, among them this very word, *Nahuatl*, all of them containing the idea "to know," or "knowledge." The early missionaries to New Spain often speak of the *naualli* (plural, *nanahualtin*), masters of mystic knowledge, dealers in the black art, wizards or sorcerers. They were not always evil-minded persons, though they seem to have been generally feared. The earliest source of information about them is Father Sahagun, who, in his invaluable History, has the following paragraph:

"The *naualli*, or magician, is he who frightens men and sucks the blood of children during the night. He is well-skilled in the practice of this trade, he knows all the arts of sorcery (*nauallotl*) and employs them with cunning and ability; but for the benefit of men only, not for their

* *Historia de las Indias Occidentales*, Dec. iv, Lib. viii, cap. 4.

† More especially it is the territory of the Chorti dialect, spoken to this day in the vicinity of the famous ancient city of Copan, Honduras. Cerquin lies in the mountains nearly due east of this celebrated site. On the Chorti, see Stoll, *Zur Ethnographie der Republik Guatemala*, pp. 106–9.

injury. Those who have recourse to such arts for evil intents injure the bodies of their victims, cause them to lose their reason and smother them. These are wicked men and necromancers."*

It is evident on examining the later works of the Roman clergy in Mexico that the Church did not look with any such lenient eye on the possibly harmless, or even beneficial, exercise of these magical devices. We find a further explanation of what they were, preserved in a work of instruction to confessors, published by Father Juan Bautista, at Mexico, in the year 1600.

"There are magicians who call themselves *teciuhtlazque*,† and also by the term *nanahualtin*, who conjure the clouds when there is danger of hail, so that the crops may not be injured. They can also make a stick look like a serpent, a mat like a centipede, a piece of stone like a scorpion, and similar deceptions. Others of these *nanahualtin* will transform themselves to all appearances (segun la aparencia), into a tiger, a dog or a weasel. Others again will take the form of an owl, a cock, or a weasel; and when one is preparing to seize them, they will appear now as a cock, now as an owl, and again as a weasel. These call themselves *nanahualtin*."‡

There is an evident attempt in this somewhat confused statement to distinguish between an actual transformation, and one which only appears such to the observer.

In another work of similar character, published at Mexico a few years later, the "Road to Heaven," of Father Nicolas de Leon, we find a series of questions which a confessor should put to any of his flock suspected of these necromantic practices. They reveal to us quite clearly what these occult practitioners were believed to do. The passage reads as follows, the questions being put in the mouth of the priest:

"Art thou a soothsayer? Dost thou foretell events by reading signs, or by interpreting dreams, or by water, making circles and figures on its surface? Dost thou sweep and ornament with flower garlands the places where idols are preserved? Dost thou know certain words with which to conjure for success in hunting, or to bring rain?

"Dost thou suck the blood of others, or dost thou wander about at night, calling upon the Demon to help thee? Hast thou drunk *peyotl*, or hast thou given it to others to drink, in order to find out secrets, or to discover where stolen or lost articles were? Dost thou know how to speak to vipers in such words that they obey thee?" §

* Bernardino de Sahagun, *Historia de la Nueva España*, Lib. x, cap. 9.

† Derived from *teciuhtlaza*, to conjure against hail, itself from *teciuh*, hail. Alonso de Molina, *Vocabulario Mexicano*, sub voce.

‡ Bautista *Advertencias para los Confesores*, fol. 112 (Mexico, 1600).

§ Nicolas de Leon, *Camino del Cielo*, fol. 111 (Mexico, 1611).

4. This interesting passage lets in considerable light on the claims and practices of the nagualists. Not the least important item is that of their use of the intoxicant, *peyotl*, a decoction of which it appears played a prominent part in their ceremonies. This is the native Nahuatl name of a certain plant, having a white, tuberous root, which is the part employed. It is mentioned as "pellote" or "peyote" in the *Farmacopea Mexicana* as a popular remedy, but its botanical name is not added. According to Paso y Troncoso, it is one of the Compositæ, a species of the genus *Cacalia*.* It is referred to in several passages by Father Sahagun, who says that it grows in southern Mexico, and that the Aztecs derived their knowledge of it from the older "Chichimecs." It was used as an intoxicant.

"Those who eat or drink of this *peyotl* see visions, which are sometimes frightful and sometimes ludicrous. The intoxication it causes lasts several days. The Chichimecs believed that it gave them courage in time of danger and diminished the pangs of hunger and thirst."†

Its use was continued until a late date, and very probably has not yet died out. Its composition and method of preparation are given in a list of beverages prohibited by the Spanish authorities in the year 1784, as follows:

"*Peyote:* Made from a species of vinagrilla, about the size of a billiard ball, which grows in dry and sterile soil. The natives chew it, and throw it into a wooden mortar, where it is left to ferment, some leaves of tobacco being added to give it pungency. They consume it in this form, sometimes with slices of *peyote* itself, in their most solemn festivities, although it dulls the intellect and induces gloomy and hurtful visions (sombras muy funestas)."‡

The *peyotl* was not the only herb prized as a means of casting the soul into the condition of hypostatic union with divinity. We have abundant evidence that long after the conquest the seeds of the plant called in Nahuatl the *ololiuhqui* were in high

* Paso y Troncoso, in *Anales del Museo Naciondl de Mexico*, Tom. iii, p. 180.

† Sahagun, *Historia de Nueva España*, Lib. x, cap. 29, and Lib. xi, cap. 7. Hernandez has the following on the mysterious properties of this plant: "Illud ferunt de hac radice mirabile (si modo fides sit vulgatissimæ inter eos rei habendæ), devorantes illam quodlibet præsagire prædicereque; velut an sequenti die hostes sint impetum in eos facturi? Anne illos felicia maneant tempora? Quis supellectilem, aut aliud quidpiam furto subripuerit? Et ad hunc modum alia, quibus Chichimecæ hujusmodi medicamine cognoscendis." Franciscus Hernandus, *Historia Plantarum Novæ Hispaniæ*, Tom. iii, p. 71 (Ed., Madrid, 1790).

‡ *Diccionario Universal*, Appendice, Tom. i, p. 360 (Mexico, 1856).

esteem for this purpose. In the Confessionary of Father Bartholomé de Alva the priest is supposed to inquire and learn as follows:

"*Question.* Hast thou loved God above all things? Hast thou loved any created thing, adoring it, looking upon it as God, and worshiping it?

"*Answer.* I have loved God with all my heart; but sometimes I have believed in dreams, and also I have believed in the sacred herbs, the *peyotl*, and the *ololiuhqui*; and in other such things (*onicneltocac in temictli, in xiuhtzintli, in peyotl, in ololiuhqui, yhuan in occequitlamantli*)."*

The seeds of the *ololiuhqui* appear to have been employed externally. They were the efficient element in the mysterious unguent known as "the divine remedy" (*teopatli*), about which we find some information in the works of Father Augustin de Vetancurt, who lived in Mexico in the middle of the seventeenth century. He writes:

"The pagan priests made use of an ointment composed of insects, such as spiders, scorpions, centipedes and the like, which the neophytes in the temples prepared. They burned these insects in a basin, collected the ashes, and rubbed it up with green tobacco leaves, living worms and insects, and the powdered seeds of a plant called *ololiuhqui*, which has the power of inducing visions, and the effect of which is to destroy the reasoning powers. Under the influence of this ointment, they conversed with the Devil, and he with them, practicing his deceptions upon them. They also believed that it protected them, so they had no fear of going into the woods at night.

"This was also employed by them as a remedy in various diseases, and the soothing influence of the tobacco and the *ololiuhqui* was attributed by them to divine agency. There are some in our own day who make use of this ointment for sorcery, shutting themselves up, and losing their reason under its influence; especially some old men and old women, who are prepared to fall an easy prey to the Devil."†

The botanist Hernandez observes that another name for this plant was *coaxihuitl*, "serpent plant," and adds that its seeds contain a narcotic poison, and that it is allied to the genus *Solanum*, of which the deadly night-shade is a familiar species. He speaks of its use in the sacred rites in these words:

"Indorum sacrifici, cum videri volebant versari cum superis, ac responsa accipere ab eis, ea vescebantur planta, ut desiperent, milleque phantasmata et demonum observatium effigies circumspectarent."‡

* *Confessionario Mayor y Menor en lengua Mexicana*, fol. 8, verso (Mexico, 1634).

† Vetancurt, *Teatro Mexicano*, Trat. iii, cap. 9.

‡ Hernandez, *Historia Plantarum Novæ Hispaniæ*, Tom. iii, p. 32.

Of the two plants mentioned, the *ololiuhqui* and the *peyotl*, the former was considered the more potent in spiritual virtues. "They hold it in as much veneration as if it were God," says a theologian of the seventeenth century.* One who partook of these herbs was called *payni* (from the verb *pay*, to take medicine); and more especially *tlachixqui*, a Seer, referring to the mystic "second sight," hence a diviner or prophet (from the verb *tlachia*, to see).

Tobacco also held a prominent, though less important, place in these rites. It was employed in two forms, the one the dried leaf, *picietl*, which for sacred uses must be broken and rubbed up either seven or nine times; and the green leaf mixed with lime, hence called *tenextlecietl* (from *tenextli*, lime).

Allied in effect to these is an intoxicant in use in southern Mexico and Yucatan, prepared from the bark of a tree called by the Mayas *baal-che*. The whites speak of the drink as *pitarilla*. It is quite popular among the natives, and they still attribute to it a sacred character, calling it *yax ha*, the first water, the primal fluid. They say that it was the first liquid created by God, and when He returned to His heavenly home He left this beverage and its production in charge of the gods of the rains, the four Pah-Ahtuns.†

**5.** Intoxication of some kind was an essential part of many of these secret rites. It was regarded as a method of throwing the individual out of himself and into relation with the supernal powers. What the old historian, Father Joseph de Acosta, tells us about the clairvoyants and telepaths of the aborigines might well stand for a description of their modern representatives:

"Some of these sorcerers take any shape they choose, and fly through the air with wonderful rapidity and for long distances. They will tell what is taking place in remote localities long before the news could possibly arrive. The Spaniards have known them to report mutinies, battles, revolts and deaths, occurring two hundred or three hundred leagues distant, on the very day they took place, or the day after.

* Dr. Jacinto de la Serna, *Manual de Ministros de Indios para el Conocimiento de sus Idolatrias y Extirpacion de Ellas*, p. 163. This interesting work was composed about the middle of the seventeenth century by a Rector of the University of Mexico, but was first printed at Madrid, in 1892, from the MS. furnished by Dr. N. Leon, under the editorship of the Marquis de la Fuensanta del Valle.

† MSS. of the Licentiate Zetina, and *Informe* of Father Baeza in *Registro Yucateco*, Tom. i.

"To practice this art the sorcerers, usually old women, shut themselves in a house, and intoxicate themselves to the degree of losing their reason. The next day they are ready to reply to questions."*

Plants possessing similar powers to excite vivid visions and distort the imagination, and, therefore, employed in the magical rites, were the *thiuimeezque*, in Michoacan, and the *chacuaco*, in lower California.†

**6.** In spite of all effort, the various classes of wonder-workers continued to thrive in Mexico. We find in a book of sermons published by the Jesuit Father, Ignacio de Paredes, in the Nahuatl language, in 1757, that he strenuously warns his hearers against invoking, consulting, or calling upon "the devilish spell-binders, the nagualists, and those who conjure with smoke."‡

They have not yet lost their power; we have evidence enough that many children of a larger growth in that land still listen with respect to the recitals of the mysterious faculties attributed to the *nanahualtin*. An observant German traveler, Carlos von Gagern, informs us that they are widely believed to be able to cause sicknesses and other ills, which must be counteracted by appropriate exorcisms, among which the reading aloud certain passages of the Bible is deemed to be one of the most potent.§

The learned historian, Orozco y Berra, speaks of the powers attributed at the present day to the *nahual* in Mexico among the lower classes, in these words:

"The *nahual* is generally an old Indian with red eyes, who knows how to turn himself into a dog, woolly, black and ugly. The female witch can convert herself into a ball of fire; she has the power of flight, and at night will enter the windows and suck the blood of little children. These sorcerers will make little images of rags or of clay, then stick into them the thorn of the maguey and place them in some secret place; you can

* Acosta, *De la Historia Moral de Indias*, Lib. v, cap. 26.

† Of the *thiuimeezque* Hernandez writes: "Aiunt radicis cortice unius unciæ pondere tuso, atque devorato, multa ante oculos observare phantasmata, multiplices imagines ac monstrificas rerum figuras, detegique furem, si quidpiam rei familiaris subreptum sit." *Hist. Plant. Nov. Hispan.*, Tom. iii, p. 272. The *chacuaco* and its effects are described by Father Venegas in his *History of California*, etc.

‡ "In Mictlan Tetlachihuique, in Nanahualtin, in Tlahuipuchtin." Paredes, *Promptuario Manual Mexicano*, p. 128 (Mexico, 1757). The *tlahuipuchtin*, "those who work with smoke," were probably diviners who foretold the future from the forms taken by smoke in rising in the air. This class of augurs were also found in Peru, where they were called *Uirapircos* (Balboa, *Hist. du Perou*, p. 28-30).

§ Von Gagern, *Charakteristik der Indianischer Bevölkerung Mexikos*, s. 125.

be sure that the person against whom the conjuration is practiced will feel pain in the part where the thorn is inserted. There still exist among them the medicine-men, who treat the sick by means of strange contortions, call upon the spirits, pronounce magical incantations, blow upon the part where the pain is, and draw forth from the patient thorns, worms, or pieces of stone. They know how to prepare drinks which will bring on sickness, and if the patients are cured by others the convalescents are particular to throw something of their own away, as a lock of hair, or a part of their clothing. Those who possess the evil eye can, by merely looking at children, deprive them of beauty and health, and even cause their death."*

7. As I have said, nowhere in the records of purely Mexican, that is, Aztecan, Nagualism do we find the word *nagual* employed in the sense given in the passage quoted from Herrera, that is as a personal guardian spirit or tutelary genius. These tribes had, indeed, a belief in some such protecting power, and held that it was connected with the day on which each person is born. They called it the *tonalli* of a person, a word translated to mean that which is peculiar to him, which makes his individuality, his self. The radical from which it is derived is *tona*, to warm, or to be warm, from which are also derived *tonatiuh*, the sun. *Tonalli*, which in composition loses its last syllable, is likewise the word for heat, summer, soul, spirit and day, and also for the share or portion which belongs to one. Thus, *to-tonal* is spirit or soul in general; *no-tonal*, my spirit; *no-tonal in ipan no-tlacat*, "the sign under which I was born," *i. e.*, the astrological day-sign. From this came the verb *tonalpoa*, to count or estimate the signs, that is, to cast the horoscope of a person; and *tonalpouhque*, the diviners whose business it was to practice this art.†

These *tonalpouhque* are referred to at length by Father Sahagun.‡ He distinguishes them from the *naualli*, though it is clear that they corresponded in functions to the nagualistic priests of the southern tribes. From the number and name of the day of

* *Historia Antigua de Mexico*, Tom. ii, p. 25. Francisco Pimentel, in his thoughtful work, *Memoria sobre las Causas que han originado la Situacion Actual de la Raza Indigena de Mexico* (Mexico, 1864), recognizes how almost impossible it is to extirpate their faith in this nagualism. "Conservan los agueros y supersticiones de la antigüedad, siendo cosa de fe para ellos, los *nahuales*," etc., p. 200, and comp. p. 145.

† On these terms consult the extensive *Dictionnaire de la Langue Nahuatl*, by Rémi Simeon, published at Paris, 1887. It is not impossible that *tona* is itself a compound root, including the monosyllabic radical *na*, which is at the basis of *nagual*.

‡ Sahagun, *Historia de Nueva España*, Lib. iv, *passim*, and Lib. x, cap. 9.

birth they forecast the destiny of the child, and stated the power or spiritual influence which should govern its career.

The *tonal* was by no means an indefeasible possession. It was a sort of independent *mascotte*. So long as it remained with a person he enjoyed health and prosperity; but it could depart, go astray, become lost; and then sickness and misfortune arrived. This is signified in the Nahuatl language by the verbs *tonalcaualtia*, to check, stop or suspend the *tonal*, hence, to shock or frighten one; and *tonalitlacoa*, to hurt or injure the *tonal*, hence, to cast a spell on one, to bewitch him.

This explains the real purpose of the conjuring and incantations which were carried on by the native doctor when visiting the sick. It was to recall the *tonal*, to force or persuade it to return; and, therefore, the ceremony bore the name "the restitution of the *tonal*," and was more than any other deeply imbued with the superstitions of Nagualism. The chief officiant was called the *tetonaltiani*, "he who concerns himself with the tonal." On a later page I shall give the formula recited on such an occasion.

**8.** There is some vague mention in the Aztec records of a semi-priestly order, who bore the name *naualteteuctin*, which may be translated "master magicians." They were also known as *teotlauice*, "sacred companions in arms." As was the case with most classes of the *teteuctin*, or nobles, entrance to the order was by a severe and prolonged ceremony of initiation, the object of which was not merely to test the endurance of pain and the powers of self-denial, but especially to throw the mind into that subjective state in which it is brought into contact with the divine, in which it can "see visions and dream dreams." The order claimed as its patron and founder Quetzalcoatl, the "feathered serpent," who, it will be seen on another page, was also the patron of the later nagualists.*

The word *naualli* also occurs among the ancient Nahuas in composition as a part of proper names; always with the signification of "magician," as in that of Naualcuauhtla, a chief of the Chalcos, meaning "wizard-stick," referring probably to the

* See Ch. de Labarthe, *Révue Américaine*, Serie ii, Tom. ii, pp. 222–225. His translation of *naualteteuctin* by "Seigneurs du génie" must be rejected, as there is absolutely no authority for assigning this meaning to *naualli*.

rod or wand employed by the magi in conjuration.* So also *Naualac*, the "wizard water," an artificial lake not far from the city of Mexico, surrounded by ruined temples, described by M. Charnay.†

**9.** The belief in a personal guardian spirit was one of the fundamental doctrines of Nagualism; but this belief by no means connotes the full import of the term (as Mr. H. H. Bancroft has erroneously stated). The calendar system of Mexico and Central America, which I have shown to be substantially the same throughout many diverse linguistic stocks,‡ had as one of its main objects, astrological divination. By consulting it the appropriate nagual was discovered and assigned, and this was certainly a prominent feature in the native cult and has never been abandoned.

In Mexico to-day, in addition to his special personal guardian, the native will often choose another for a limited time or for a particular purpose, and this is quite consistent with the form of Christianity he has been taught. For instance, as we are informed by an observant traveler, at New Year or at corn-planting the head of a family will go to the parish church and among the various saints there displayed will select one as his guardian for the year. He will address to him his prayers for rain and sunshine, for an abundant harvest, health and prosperity, and will not neglect to back these supplications by liberal gifts. If times are good and harvests ample the Santo is rewarded with still more gifts, and his aid is sought for another term; but if luck has been bad the Indian repairs to the church at the end of the year, bestows on his holy patron a sound cursing, calls him all the bad names he can think of, and has nothing more to do with him.§

**10.** A Mexican writer, Andres Iglesias, who enjoyed more than common opportunities to study these practices as they exist in the present generation, describes them as he saw them in the village of Soteapan, a remote hamlet in the State of Vera Cruz, the population of which speak the Mixe language. This

* *Anales de Cuauhtitlan*, p. 31. The translator renders it "palo brujo."

† *Les Anciennes Villes du Nouveau Monde*, pp. 146–148, figured on p. 150. On its significance compare Hamy, *Decades Americanæ*, pp. 74–81.

‡ *The Native Calendar of Central America and Mexico* (Philadelphia, 1893).

§ Eduard Mühlenpfordt, *Mexico*, Bd. i, s. 255.

is not related to the Nahuatl tongue, but the terms of their magical rites are drawn from Nahuatl words, showing their origin. Every person at birth has assigned to him both a good and a bad genius, the former aiming at his welfare, the latter at his injury. The good genius is known by the Nahuatl term *tonale*, and it is represented in the first bird or animal of any kind which is seen in or near the house immediately after the birth of the infant.

The most powerful person in the village is the high priest of the native cult. One who died about 1850 was called "the Thunderbolt," and whenever he walked abroad he was preceded by a group of chosen disciples, called by the Nahuatl name *tlatoques*, speakers or attorneys.* His successor, known as "the Greater Thunder," did not maintain this state, but nevertheless claimed to be able to control the seasons and to send or to mitigate destructive storms—claims which, sad to say, brought him to the stocks, but did not interfere with the regular payment of tribute to him by the villagers. He was also a medicine man and master of ceremonies in certain "scandalous orgies, where immodesty shows herself without a veil."

**11.** Turning to the neighboring province of Oaxaca and its inhabitants, we are instructed on the astrological use of the calendar of the Zapotecs by Father Juan de Cordova, whose *Arte* of their language was published at Mexico in 1578. From what he says its principal, if not its only purpose, was astrological. Each day had its number and was called after some animal, as eagle, snake, deer, rabbit, etc. Every child, male or female, received the name of the day, and also its number, as a surname; its personal name being taken from a fixed series, which differed in the masculine and feminine gender, and which seems to have been derived from the names of the fingers.

From this it appears that among the Zapotecs the personal spirit or *nagual* was fixed by the date of the birth, and not by some

* The word is derived from *tlatoa*, to speak for another, and its usual translation was "chief," as the head man spoke for, and in the name of the gens or tribe.

† The interesting account by Iglesias is printed in the Appendix to the *Diccionario Universal de Geographia y Historia* (Mexico, 1856). Other writers testify to the tenacity with which the Mixes cling to their ancient beliefs. Señor Moro says they continue to be "notorious idolaters," and their actual religion to be "an absurd jumble of their old superstitions with Christian doctrines" (in Orozco y Berra, *Geografia de las Lenguas de Mexico*, p. 176).

later ceremony, although the latter has been asserted by some writers; who, however, seem to have applied without certain knowledge the rites of the Nahuas and other surrounding tribes to the Zapotecs.*

Next in importance to the assigning of names, according to Father Cordova, was the employment of the calendar in deciding the propriety of marriages. As the recognized object of marriage was to have sons, the couple appealed to the professional augur to decide this question before the marriage was fixed. He selected as many beans as was the sum of the numbers of the two proponents' names, and, counting them by twos, if one remained over, it meant a son; then counting by threes any remainder also meant sons; by fours the remainder meant either sons or daughters; and by five and six the same; and if there was no remainder by any of these five divisors the marriage would result in no sons and was prohibited.

It is obvious that this method of fortune-telling was most auspicious for the lovers; for I doubt if there is any combination of two numbers below fourteen which is divisible by two, three, four, five and six without remainder in any one instance.†

The Zapotecs were one of those nations who voluntarily submitted themselves to the Spaniards, not out of love for the Europeans, but through hatred of the Aztecs, who had conquered them in the preceding century. Their king, Coyopy, and his subjects accepted Christianity. and were generally baptized; but it was the merest formality, and years afterwards Coyopy was detected secretly conducting the heathen ritual of his ancestors with all due pomp. He was arrested, sent to the city of Mexico, deprived of his power and wealth, and soon died; it is charitably supposed, from natural causes. There is no question but that he left successors to the office of pontifex maximus, and that they continued the native religious ceremonies.

**12.** The sparse notices we have of the astrology of the Mixtecs, neighbors and some think relatives of the Zapotecs, reveal

* For instance, J. B. Carriedo, in his *Estudios Historicos del Estado Oaxaqueño* (Oaxaca, 1849), p. 15, says the *nahualt* was a ceremony performed by the native priest, in which the infant was bled from a vein behind the ear, assigned a name, that of a certain day, and a guardian angel or *tona*. These words are pure Nahuatl, and Carriedo, who does not give his authority, probably had none which referred these rites to the Zapotecs.

† Juan de Cordova, *Arte en Lengua Zapoteca*, pp. 16, 202, 203, 213, 216.

closely similar rites. The name of their king, who opposed Montezuma the First some sixty years before the arrival of Cortez, proves that they made use of the same or a similar calendar in bestowing personal appellations. It is given as *Tres Micos*, Three Monkeys.

Unfortunately, so far as I know, there has not been published, and perhaps there does not exist, an authentic copy of the Mixtec calendar. It was nevertheless reduced to writing in the native tongue after the conquest, and a copy of it was seen by the historian Burgoa in the Mixtec town of Yanhuitlan.* Each day was named from a tree, a plant or an animal, and from them the individual received his names, as Four Lions, Five Roses, etc. (examples given by Herrera). This latter writer adds that the name was assigned by the priests when the child was seven years old (as among the Tzentals), part of the rite being to conduct it to the temple and bore its ears. He refers also to their auguries relating to marriage.† These appear to have been different from among the Zapotecs. It was necessary that the youth should have a name bearing a higher number than that of the maiden, and also "that they should be related;" probably this applied only to certain formal marriages of the rulers which were obliged to be within the same *gens*.

**13.** I have referred in some detail to the rites and superstitions connected with the Calendar because they are all essential parts of Nagualism, carried on far into Christian times by the priests of this secret cult, as was fully recognized by the Catholic clergy. Wherever this calendar was in use, the Freemasonry of Nagualism extended, and its ritual had constant reference to it. Our fullest information about it does not come from central Mexico, but further south, in the region occupied by the various branches of the Mayan stock, by the ancestors of some one of which, perhaps, this singular calendar, and the symbolism connected with it, were invented.

One of the most important older authorities on this subject is Francisco Nuñez de la Vega, a learned Dominican, who was appointed Bishop of Chiapas and Soconusco in 1687, and who published at Rome, in 1702, a stately folio entitled "*Constitu-*

* Quoted in Carriedo, ubi suprá, p. 17.

† *Hist. de las Indias Oc.*, Dec. iii, Lib. iii, cap. 12.

*ciones Diœcesanas del Obispado de Chiappa*," comprising discussions of the articles of religion and a series of pastoral letters. The subject of Nagualism is referred to in many passages, and the ninth Pastoral Letter is devoted to it. As this book is one of extreme rarity, I shall make rather lengthy extracts from it, taking the liberty of condensing the scholastic prolixity of the author, and omitting his professional admonitions to the wicked.

He begins his references to it in several passages of his Introduction or *Preambulo*, in which he makes some interesting statements as to the use to which the natives put their newly-acquired knowledge of writing, while at the same time they had evidently not forgotten the ancient method of recording ideas invented by their ancestors.

The Bishop writes:

"The Indians of New Spain retain all the errors of their time of heathenism preserved in certain writings in their own languages, explaining by abbreviated characters and by figures painted in a secret cypher * the places, provinces and names of their early rulers, the animals, stars and elements which they worshiped, the ceremonies and sacrifices which they observed, and the years, months and days by which they predicted the fortunes of children at birth, and assign them that which they call the Naguals. These writings are known as Repertories or Calendars, and they are also used to discover articles lost or stolen, and to effect cures of diseases. Some have a wheel painted in them, like that of Pythagoras, described by the Venerable Bede; others portray a lake surrounded by the Naguals in the form of various animals. Some of the Nagualist Masters claim as their patron and ruler Cuchulchan, and they possessed a certain formula of prayer to him, written in the Popoluca tongue (which was called Baha in their time of heathenism), and which has been translated into Mexican.†

"Those who are selected to become the masters of these arts are taught from early childhood how to draw and paint these characters, and are obliged to learn by heart the formulas, and the names of the ancient Nagualists, and whatever else is included in these written documents, many of which we have held in our hands, and have heard them explained by such masters whom we had imprisoned for their guilt, and who had afterwards become converted and acknowledged their sins."‡

* So I understand the phrase, "figuras pintadas con zifras enigmaticas."

† *Popoluca* was a term applied to various languages. I suspect the one here referred to was the Mixe. See an article by me, entitled "Chontales and Popolucas; a Study in Mexican Ethnography," in the *Compte Rendu* of the Eighth Session of the Congress of Americanists, p. 556, *seq.*

‡ *Constit. Diocesan*, p. 19.

The Bishop made up his mind that extreme measures should be taken to eradicate these survivals of the ancient paganism in his diocese, and he therefore promulgated the following order in the year 1692:

"And because in the provinces of our diocese those Indians who are Nagualists adore their *naguals*, and look upon them as gods, and by their aid believe that they can foretell the future, discover hidden treasures, and fulfill their dishonest desires: we, therefore, prescribe and command that in every town an ecclesiastical prison shall be constructed at the expense of the church, and that it be provided with fetters and stocks (con grillos y cepos), and we confer authority on every priest and curate of a parish to imprison in these gaols whoever is guilty of disrespect toward our Holy Faith, and we enjoin them to treat with especial severity those who teach the doctrines of Nagualism (y con rigor mayor á los dogmatizantes Nagualistas)." *

In spite of these injunctions it is evident that he failed to destroy the seeds of what he esteemed this dangerous heresy in the parishes of his diocese; for his ninth Pastoral Letter, in which he exposes at length the character of Nagualism, is dated from the metropolitan city of Ciudad Real, on May 24, 1698. As much of it is germane to my theme, I translate as follows:

"There are certain bad Christians of both sexes who do not hesitate to follow the school of the Devil, and to occupy themselves with evil arts, divinations, sorceries, conjuring, enchantments, fortune-telling, and other means to forecast the future.

"These are those who in all the provinces of New Spain are known by the name of *Nagualists*. They pretend that the birth of men is regulated by the course and movements of stars and planets, and by observing the time of day and the months in which a child is born, they prognosticate its condition and the events, prosperous or otherwise, of its life; and the worst is that these perverse men have written down their signs and rules, and thus deceive the erring and ignorant.

"These Nagualists practice their arts by means of Repertories and superstitious Calendars, where are represented under their proper names all the Naguals of stars, elements, birds, fishes, brute beasts and dumb animals; with a vain note of days and months, so that they can announce which corresponds to the day of birth of the infant. This is preceded by some diabolical ceremonies, after which they designate the field or other spot, where, after seven years shall have elapsed, the Nagual will appear to ratify the bargain. As the time approaches, they instruct the child to

* *Constitut. Diocesan*, Titulo vii, pp. 47, 48.

deny God and His Blessed Mother, and warn him to have no fear, and not to make the sign of the cross. He is told to embrace his Nagual tenderly, which, by some diabolical art, presents itself in an affectionate manner even though it be a ferocious beast, like a lion or a tiger. Thus, with infernal cunning they persuade him that this Nagual is an angel of God, who will look after him and protect him in his after life.

"To such diabolical masters the intelligent Indians apply, to learn from these superstitious Calendars, dictated by the Devil, their own fortunes, and the Naguals which will be assigned to their children, even before they are baptized. In most of the Calendars, the seventh sign is the figure of a man and a snake, which they call Cuchulchan. The masters have explained it as a snake with feathers which moves in the water. This sign corresponds with Mexzichuaut, which means Cloudy Serpent, or, of the clouds.* The people also consult them in order to work injury on their enemies, taking the lives of many through such devilish artifices, and committing unspeakable atrocities.

"Worse even than these are those who wander about as physicians or healers; who are none such, but magicians, enchanters, and sorcerers, who, while pretending to cure, kill whom they will. They apply their medicines by blowing on the patient, and by the use of infernal words; learned by heart by those who cannot read or write; and received in writing from their masters by those acquainted with letters. The Master never imparts this instruction to a single disciple, but always to three at a time, so that in the practice of the art it may be difficult to decide which one exerts the magical power. They blow on feathers, or sticks, or plants, and place them in the paths where they may be stepped on by those they wish to injure, thus causing chills, fevers, ugly pustules and other diseases; or they introduce into the body by such arts toads, frogs, snakes, centipedes, etc., causing great torments. And by these same breathings and magic words they can burn down houses, destroy the growing crops and induce sickness. No one of the three disciples is permitted to practice any of these arts without previously informing the other two, and also the Master, by whom the three have been taught.

"We have learned by the confession of certain guilty parties how the Master begins to instruct his disciple. First he tells him to abjure God, the saints and the Virgin, not to invoke their names, and to have no fear of them. He then conducts him to the wood, glen, cave or field where the pact with the Devil is concluded, which they call 'the agreement' or 'the word given' (in Tzental *quiz*). In some provinces the disciple is laid on an ant-hill, and the Master standing above him calls forth a snake, colored with black, white and red, which is known as 'the ant-mother' (in Tzental *zmezquiz*).† This comes accompanied by the ants

* Rather with the Quetzalcoatl of the Nahuas, and the Gucumatz of the Quiches, both of which names mean "Feathered Serpent." Mixcohuatl, the Cloud Serpent, in Mexican mythology, referred to the Thunder-storm.

† In his Tzental Vocabulary, Father Lara does not give this exact form; but in the neighboring dialect of the Cakchiquel Father Ximenes has *quikeho*, to agree together, to enter into an arrangement; the prefix *zme* is the Tzental word for "mother."

and other small snakes of the same kind, which enter at the joints of the fingers, beginning with the left hand, and coming out at the joints of the right hand, and also by the ears and the nose; while the great snake enters the body with a leap and emerges at its posterior vent. Afterwards the disciple meets a dragon vomiting fire, which swallows him entire and ejects him posteriorly. Then the Master declares he may be admitted, and asks him to select the herbs with which he will conjure; the disciple names them, the Master gathers them and delivers them to him, and then teaches him the sacred words.

"These words and ceremonies are substantially the same in all the provinces. The healer enters the house of the invalid, asks about the sickness, lays his hand on the suffering part, and then leaves, promising to return on the day following. At the next visit he brings with him some herbs which he chews or mashes with a little water and applies to the part. Then he repeats the *Pater Noster*, the *Ave*, the *Credo* and the *Salve*. and blows upon the seat of disease, afterwards pronouncing the magical words taught him by his master. He continues blowing in this manner, inhaling and exhaling, repeating under his breath these magical expressions, which are powerful to kill or to cure as he chooses, through the compact he has made with the Devil. Finally, so as to deceive the bystanders, he ends with saying in a loud voice: 'God the Father, God the Son, and God the Holy Ghost. Amen.'

"This physician or healer is called in the towns of some of the provinces *poxta vanegs*, and the medicine *gspoxil;* and everything relating to healing among the Indians to which they apply these terms means also to practice sorcery; and all words derived from *pox* allude to the Nagual; for this in some provinces is called *poxlon*, and in others *patzlan*, and in many *tzihuizin*, which is something very much feared by the Indians. We have ascertained by the confessions of many who have been reconciled that the Devil at times appears to them in the shape of a ball or globe of fire in the air, with a tail like a comet.*

"According to the most ancient traditions of these Indians this idol, *poxlon*, was one of the most important and venerated they had in the old

* Father Lara, in his *Vocabulario Tzendal MS.* (in my possession), gives for medical (medico), *ghpoxil;* for medicine (medicinal cosa), *pox*, *xpoxtacoghbil;* for physician (medico), *ghpoxta vinic* (the form *vanegh*, person, is also correct). The Tzendal *pox* (pronounced *pōsh*) is another form of the Quiche-Cakchiquel *pūz*, a word which Father Ximenes, in his *Vocabulario Cakchiquel* MS. (in my possession), gives in the compound *puz-naual*, with the meaning, enchanter, wizard. Both these, I take it, are derived from the Maya *puz*, which means to blow the dust, etc., off of something (soplar el polvo de la ropa ó otra cosa. *Dicc. de la Lengua Maya del Convento de Motul*, MS. The dictionary edited by Pio Perez does not give this meaning). The act of blowing was the essential feature in the treatment of these medicine men. It symbolized the transfer and exercise of spiritual power. When Votan built his underground shrine he did it *á soplos*, by blowing (Nuñez de la Vega, *Constitut. Diocesan*, p. 10). The natives did not regard the comet's tail as behind it but in front of it, blown from its mouth. The Nahuatl word in the text, *tzihuizin*, is the Pipil form of *xihuitzin*, the reverential of *xihuitl*, which means a leaf, a season, a year, or a comet. Apparently it refers to the Nahuatl divinity *Xiuhtlcutli*, described by Sahagun, *Historia de Nueva España*, Lib. I, cap. 13, as god of fire, etc.

times, and the Tzentals revered it so much that they preserved it innumerable years painted on a tablet in the above figure. Even after they were converted to the faith, they hung it behind a beam in the church of the town of Oxchuc, accompanied by an image of their god Hicalahau, having a ferocious black face with the members of a man,* along with five owls and vultures. By divine interposition, we discovered these on our second visit there in 1687, and had no little difficulty in getting them down, we reciting the creed, and the Indians constantly spitting as they executed our orders. These objects were publicly burned in the plaza.

"In other parts they reverence the bones of the earlier Nagualists, preserving them in caves, where they adorn them with flowers and burn copal before them. We have discovered some of these and burned them, hoping to root out and put a stop to such evil ceremonies of the infernal sect of the Nagualists.

"At present, all are not so subject to the promptings of the Devil as formerly, but there are still some so closely allied to him that they transform themselves into tigers, lions, bulls, flashes of light and globes of fire. We can say from the declaration and solemn confession of some penitents that it is proved that the Devil had carnal relations with them, both as incubus and succubus, approaching them in the form of their Nagual; and there was one woman who remained in the forest a week with the demon in the form of her Nagual, acting toward him as does an infatuated woman toward her lover (como pudiera con su proprio amigo una muger amancebada). As a punishment for such horrible crimes our Lord has permitted that they lose their life as soon as their Nagual is killed; and that they bear on their own bodies the wound or mark of the blow which killed it; as the curas of Chamula, Copainala and other places have assured us.

"The devilish seed of this Nagualism has rooted itself in the very flesh and blood of these Indians. It perseveres in their hearts through the instructions of the masters of the sect, and there is scarcely a town in these provinces in which it has not been introduced. It is a superstitious idolatry, full of monstrous incests, sodomies and detestable bestialities."

Such are the words of the Bishop of Chiapas. We learn from his thoroughly instructed and unimpeachable testimony that at the beginning of the eighteenth century Nagualism was a widespread and active institution among the Indians of southern Mexico; that it was taught and practiced by professors who were so much feared and respected that, as he tells us in another passage, they were called "masters of the towns;"† that they gave systematic instruction to disciples in classes of

* *Hicalahau*, for *ical ahau*, Black King, one of the Tzental divinities, who will be referred to on a later page.

† "Mæstros de los pueblos," *Constitut. Dioecesan*, I, p. 106.

three, all of whom were bound together by pledges of mutual information and assistance; that a fundamental principle of the organization and an indispensable step in the initiation into its mysteries was the abjuration of the Christian religion, and an undying hatred to its teachers and all others of the race of the white oppressors; and that when they made use of Christian phrases or ceremonies it was either in derision or out of hypocrisy, the better to conceal their real sentiments.

There are a number of other witnesses from the seventeenth century that may be summoned to strengthen this testimony, if it needs it.

**14.** In the *History of Guatemala*, written about 1690 by Francisco Antonio Fuentes y Guzman, the author gives some information about a sorcerer of this school, who was arrested in Totonicapan, and with whom the historian had something to do as *corregidor*.

The redoubtable magician was a little old man, *viejezuelo*, and when caught had in his possession a document giving the days of the year according to the European calendar, with the Nagual, which belonged to each one. That for January is alone given by our writer, but it is probable that the other months merely repeated the naguals corresponding to the numbers. It ran as follows:

*Nagual Calendar for January.*

1. Lion.
2. Snake.
3. Stone.
4. Alligator.
5. Ceiba tree.
6. The quetzal (a bird).
7. A stick.
8. Rabbit.
9. A rope.
10. Leaf.
11. Deer.
12. Guacamayo (parrot).
13. Flower.
14. Toad.
15. Caterpillar.
16. A chip.
17. Arrow.
18. Broom.
19. Jaguar.
20. Corn-husk.
21. A flute.
22. Green-stone.
23. Crow.
24. Fire.
25. A pheasant.
26. A reed.
27. Opossum.
28. Huracan (the thunder-storm).
29. The vulture.
30. Hawk.
31. Bat.

When the sorcerer was examined as to the manner of assigning the proper nagual to a child he gave the following account: Having been informed of its day of birth, he in due time called at the residence of the parents, and told the mother to bring the child into the field behind the house. Having there invoked the demon, the *nagual* of the child would appear under the form of the animal or object set opposite its birthday in the calendar, a serpent were it born on the 2d of January, a flower were it on the 13th, fire were it on the 24th, and so on. The sorcerer then addressed certain prayers to the *nagual* to protect the little one, and told the mother to take it daily to the same spot, where its *nagual* would appear to it, and would finally accompany it through all its life. Some, but not all, obtained the power of transforming themselves into the *nagual*, and the author declares that, though he could not cite such a case from his own experience, his father knew of several, and reliable priests, *religiosos de fé*, had told him enough examples to fill volumes.*

The tribes to which this author refers were the Cakchiquels and Quiches, who spoke practically the same tongue. An examination of some of the old dictionaries prepared by the early missionaries furnishes further and interesting information about this obscure subject.

In the Cakchiquel language of Guatemala, the word *naual* was applied both to the magician himself, to his necromantic art, and to the demonic agency which taught and protected him. This is shown by the following explanation, which I quote from Father Coto's *Vocabulario de la Lengua Cakchiquel*, 1651, a manuscript in the library of the American Philosophical Society:

"*Magic* or *Necromancy : puz* or *naual ;* and they were accustomed to call their magicians or sorcerers by the same terms. It was a kind of magic which they invoked in order to transform themselves into eagles, lions, tigers, etc. Thus, they said, *ru puz, ru naual, pedro la cot, balam,* 'Peter's power. his *naual,* is a lion, a tiger.' They also applied the words *puz* and *naual* to certain trees, rocks and other inanimate objects, whence the Devil used to speak to them, and likewise to the idols which they worshiped, as *gazlic che, gazlic abah, huyu, k'o ru naual,* 'The life of the tree, the life of the stone, of the hill, is its *naual,*' etc.; because they believed there was life in these objects. They used to have armies and

* *Historia de Guatemala, ó, Recordacion Florida,* Tom. ii, p. 44, *seq.*

soldiery to guard their lands, and the captains, as well as many who were not captains, had their *nauales*. They called the captain *ru g' alache; rohobachi, ti ru gaah, ru pocob, ru gh' amay a ghay ti be chi naualil* [he works magic with his shield, his lance, and his arrows].

"To practice such magical arts: *tin naualih* ('I practice magic'), an active verb. They use it, for instance, when a man asks his wife for something to eat or drink, and she has nothing, owing to his negligence, she will say: 'Where do you suppose I can get what you want? Do you expect me to perform miracles—*xa pe ri tin naualih*—that they shall come to my hands?' So when one is asked to lend or give something which he has not, he will exclaim: *Tin naualih pe ri puvak*, etc. ('Can I perform miracles,' etc.)

"It also signifies to pretend something, concealing the truth, as *xa ru naualim ara neh chu g' ux ri tzih tan tu bijh pedro*, 'Peter is feigning this which he is saying.' They are also accustomed to apply this word to the power which the priests exert (in the sacraments, etc.)."

A long and foolish account of the witchcraft supposed to be practiced among the Pokonchis of Guatemala, also a tribe of Mayan stock, is given by the Englishman, Thomas Gage, who was cura of a parish among them about 1630, and afterwards returned to England and Protestantism. He described, at wearisome length, the supposed metamorphosis of two chiefs of neighboring tribes, the one into a lion, the other into a tiger, and the mortal combat in which they engaged, resulting in the death of one to whom Gage administered absolution. No doubt he had been worsted in a personal encounter with his old enemy, and, being a man of eighty years, had not the vigor to recover. The account is of interest only as proving that the same superstitions at that time prevailed among the Pokonchis as in other portions of Guatemala.*

**15.** A really mighty nagualist was not confined to a single transformation. He could take on many and varied figures. One such is described in the sacred books of the Quiches of Guatemala, that document known by the name of the Popol Vuh, or National Book. The passage is in reference to one of their great kings and powerful magicians, Gucumatz by name. It says:

"Truly he was a wonderful king. Every seven days he ascended to the sky, and every seven days he followed the path to the abode of the

* Gage, *A New Survey of the West Indies*, p. 388, *seq.* (4th Ed.).

dead; every seven days he put on the nature of a serpent, and then he became truly a serpent; every seven days he assumed the nature of an eagle, and then he became truly an eagle; then of a tiger and he became truly a tiger; then of coagulated blood, and he was nothing else than coagulated blood."*

It may be said that such passages refer metaphorically to the versatility of his character, but even if this is so, the metaphors are drawn from the universal belief in Nagualism which then prevailed, and they do not express it too strongly.

**16.** Among the Maya tribes of Yucatan and Guatemala we have testimony to the continuance to this day of these beliefs. Father Bartolomé de Baeza, cura of Yaxcaba in the first half of this century, reports that an old man, in his dying confession, declared that by diabolical art he had transformed himse f into an animal, doubtless his *nagual;* and a young girl of some twelve years confessed that she had been transformed into a bird by the witches, and in one of her nocturnal flights had rested on the roof of the very house in which the good priest resided, which was some two leagues from her home. He wisely suggests that, perhaps, listening to some tale of sorcery, she had had a vivid dream, in which she seemed to take this flight. It is obvious, however, from his account, as well as from other sources, that the belief of the transformation into lower animals was and is one familiar to the superstitions of the Mayas.† The natives still continue to propitiate the ancient gods of the harvest, at the beginning of the season assembling at a ceremony called by the Spaniards the *misa milpera*, or "field mass," and by themselves *ti'ch*, "the stretching out of the hands."

The German traveler, Dr. Scherzer, when he visited, in 1854, the remote hamlet of Istlavacan, in Guatemala, peopled by Quiché Indians, discovered that they had preserved in this respect the usages of their ancestors almost wholly unaffected by the teachings of their various Christian curates. The "Master" still assigned the *naguals* to the new-born infants, copal was burned to their ancient gods in remote caves, and formulas of

* *Le Popol Vuh, ou Livre Sacré des Quichés*, p. 315 (Ed. Brasseur, Paris, 1861). In the Quiche myths, Gucumatz is the analogue of Quetzalcoatl in Aztec legend. Both name mean the same, "Feathered Serpent."

† Baeza's article is printed in the *Registro Yucateco*, Vol. 1, p. 165, *seq.*

invocation were taught by the veteran nagualists to their neophytes.*

These *Zahoris*,† as they are generally called in the Spanish of Central America, possessed many other mysterious arts besides that of such metamorphoses and of forecasting the future. They could make themselves invisible, and walk unseen among their enemies; they could in a moment transport themselves to distant places, and, as quickly returning, report what they had witnessed; they could create before the eyes of the spectator a river, a tree, a house, or an animal, where none such existed; they could cut open their own stomach, or lop a limb from another person, and immediately heal the wound or restore the severed member to its place; they could pierce themselves with knives and not bleed, or handle venomous serpents and not be bitten; they could cause mysterious sounds in the air, and fascinate animals and persons by their steady gaze; they could call visible and invisible spirits, and the spirits would come.

Among the native population of the State of Vera Cruz and elsewhere in southern Mexico these mysterious personages go by the name *padrinos*, godfathers, and are looked upon with a mixture of fear and respect. They are believed by the Indians to be able to cause sickness and domestic calamities, and are pronounced by intelligent whites to present "a combination of rascality, duplicity and trickery."‡

**17.** The details of the ceremonies and doctrines of Nagualism have never been fully revealed; but from isolated occurrences and partial confessions it is clear that its adherents formed a coherent association extending over most of southern

* "Wird ein Kind im Dorfe geboren, so erhält der heidnische Götzenpriester von diesem Ereignisse viel eher Kunde, als der katholische Pfarrer. Erst wenn dem neuen Weltbürger durch den Aj-quig das Horoskop gestellt, der Name irgend eines Thieres beigelegt, Mi-si-sal (das citronengelbe Harz des Rhus copallinum) verbrannt, ein Lieblingsgötze angerufen, und noche viele andere abergläubische Mysterien verrichtet worden sind, wird das Kind nach dem Pfarrhause zur christlichen Taufe getragen. Das Thier, dessen Name dem Kinde kurz nach seiner Geburt vom Sonnenpriester beigelegt wird, gilt gewöhnlich auch als sein Schutzgeist (*nagual*) fürs ganze Leben." Dr. Karl Scherzer, *Die Indianer von Santa Catalina Istlavacan*, p. 11, Wien, 1856.

† The word *zahori*, of Arabic origin, is thus explained in the Spanish and English dictionary of Delpino (London, 1763): "So they call in Spain an impostor who pretends to see into the bowels of the earth, through stone walls, or into a man's body." Dr. Stoll says the Guatemala Indians speak of their diviners, the *Ah Kih*, as *zahorin*. *Guatemala*, s. 229.

‡ Emetorio Pineda, *Descripcion Geografica de Chiapas y Soconusco*, p. 22 (Mexico, 1845).

Mexico and Guatemala, which everywhere was inspired by two ruling sentiments—detestation of the Spaniards and hatred of the Christian religion.

In their eyes the latter was but a cloak for the exactions, massacres and oppressions exerted by the former. To them the sacraments of the Church were the outward signs of their own subjugation and misery. They revolted against these rites in open hatred, or received them with secret repugnance and contempt. In the Mexican figurative manuscripts composed after the conquest the rite of baptism is constantly depicted as the symbol of religious persecution. Says a sympathetic student of this subject:

"The act of baptism is always inserted in their records of battles and massacres. Everywhere it conveys the same idea,—making evident to the reader that the pretext for all the military expeditions of the Spaniards was the enforced conversion to Christianity of the natives; a pretext on which the Spaniards seized in order to possess themselves of the land and its treasure, to rob the Indians of their wives and daughters, to enslave them, and to spill their blood without remorse or remission. One of these documents, dated in 1526, adds a trait of savage irony. A Spanish soldier is represented dragging a fugitive Indian from a lake by a lasso around his neck; while on the shore stands a monk ready to baptize the recreant on his arrival!"*

No wonder that the priests of the dark ritual of Nagualism for centuries after the conquest sought to annul the effects of the hated Christian sacraments by counteracting ceremonies of their own, as we are told they did by the historian Torquemada, writing from his own point of view in these words:

"The Father of Lies had his ministers who aided him, magicians and sorcerers, who went about from town to town, persuading the simple people to that which the Enemy of Light desired. Those who believed their deceits, and had been baptized, were washed on the head and breast by these sorcerers, who assured them that this would remove the effects of the chrism and the holy oils. I myself knew an instance where a person of prominence, who resided not far from the City of Mexico, was dying, and had received extreme unction; and when the priest had departed one of these diabolical ceremonialists entered, and washed all the parts which had been anointed by the holy oil with the intention to destroy its power."†

* Madier de Montjau, "Manuscrits Figuratifs de l' Ancien Mexique," in *Archives de la Société Americaine de France*, 1875, p. 215.

† Torquemada, *Monarquia Indiana*, Lib. xv, cap. 16.

Similar instances are recorded by Jacinto de la Serna. He adds that not only did the Masters prescribe sacrifices to the Fire in order to annul the effects of extreme unction, but they delighted to caricature the Eucharist, dividing among their congregation a narcotic yellow mushroom for the bread, and the inebriating pulque for the wine. Sometimes they adroitly concealed in the pyx, alongside the holy wafer, some little idol of their own, so that they really followed their own superstitions while seemingly adoring the Host. They assigned a purely pagan sense to the sacred formula, "Father, Son and Holy Ghost," understanding it to be "Fire, Earth and Air," or the like.*

Whoever or whatever was an enemy to that religion so brutally forced upon these miserable creatures was to them an ally and a friend. Nuñez de la Vega tells us that he found written formulas among them reading: "O Brother Antichrist, Brother Antichrist, Brother Antichrist, come to our aid!"—pathetic and desperate appeal of a wretched race, ground to earth under the iron heels of a religious and military despotism.†

**18.** The association embraced various tribes and its members were classified under different degrees. The initiation into these was by solemn and often painful ceremonies. Local sodalities or brotherhoods were organized after the manner of those usual in the Roman Church; but instead of being named after St. John or the Virgin Mary they were dedicated to Judas Iscariot or Pontius Pilate out of derision and hatred of the teachings of the priests; or to the Devil or Antichrist, who were looked upon as powerful divinities in opposition to the Church.‡

There were certain recognized centres of the association, near which its most important dignitaries resided, and where their secret councils and most imposing ceremonies were held. One of these was Zamayac, in the province of Suchiltepec; a second near Huehuetan, Soconusco; a third at Totonicapan, Guate-

* De la Serna, *Manual de Ministros*, pp. 20, 21, 42, 162. The mushroom referred to was the *quauhnanacatl*, probably the same as the *teyhuinti* of Hernandez, *Hist. Plant. Nov. Hispan.*, Tom. ii, p. 358, who says that it is not dangerous to life, but disturbs the mind, inciting to laughter and intoxication.

† Actual slavery of the Indians in Mexico continued as late as the middle of the seventeenth century. See Cavo, *Tres Siglos de Mexico*, etc., Tom. ii, p. 11.

‡ Brasseur, *Hist. des Nations Civilisées de Mexique*, Tom. iv, p. 822.

mala; a fourth at Cancuc, Chiapas; a fifth at Teozapotlan, Oaxaca; and a few others may be surmised.

The high priest who resided at each of these centres exercised control over all the nagualistic teachers and practitioners in an extensive district. On the occasion of an official inquiry by the Spanish authorities it was ascertained that the high priest of Zamayac included under his rule nearly one thousand sub-priests,* and no doubt others of his rank were not less potent.

The unity between the members of the association over an indefinitely wide area was perfectly well known to the Spanish priests and civil authorities. The ceremonies, formulas and methods of procedure were everywhere identical or alike. This itself was justly regarded as a proof of the secret intelligence which existed among the members of this cabalistic guild.†

To a certain extent, and at least in some localities, as Chiapas and Guatemala, the priesthood of Nagualism was hereditary in particular families. This is especially stated by the historian Ordoñez y Aguiar, who had exceptional opportunities for acquainting himself with the facts.‡

A traveler of the first decade of this century, who has left us a number of curious details of the superstitions of the Christianized Indians in Mexico of that day, Benito Maria de Moxò, informs us that he had discovered the existence of different grades in the native soothsayers and medicine men, and that all in a given locality recognized the supremacy of one whom they referred to as "the little old man," *El Viejito*. But he was unable to ascertain by what superior traits or rights he obtained this distinction.§

According to some authorities, the highest grade of these native hierophants bore among the Nahuas the symbolic name

* *Informe del teniente general, Don Jacobo de Barba Figueroa, corregidor de la Provincia de Suchitepeque*. quoted by Brasseur.

† Jacinto de la Serna says: "Los mæstros de estas ceremonias son todos unos, y lo que sucede en esta cordillera en todas sucede." *Manual de Ministros*, p. 52. Speaking of the methods of the nagualists of Chiapas, Bishop Nuñez de la Vega writes: "Concuerdan los mas modernos con los mas antiguos que se practicaban en Mexico." *Constituciones Diocesanas*, p. 134.

‡ He observes that there were "familias de los tales sabios en las quales en manera de patrimonio se heredaban, succediendo los hijos á los padres, y principalmente su abominable secta de Nagualismo." *Historia del Cielo y de la Tierra*, MS., p. 7. Ordoñez advances various erudite reasons for believing that Nagualism is a religious belief whose theory and rites were brought from Carthage by Punic navigators in ancient times.

§ Maria de Moxó, *Cartas Mejicanas*, p. 270 (Genova, n. d.).

of "flower-weavers," *Xochimilca*, probably from the skill they had to deceive the senses by strange and pleasant visions.* In the south they were spoken of as "guardians," which may have been derived from the classes of priests so-called in the Zapotec religion.†

**19.** It will be seen from the above, that Nagualism, beginning in an ancient superstition dating back to the time of primitive barbarism, became after the Conquest a potent factor in the political and social development of the peoples among whom it existed; that it was the source from which was drawn and the means by which was sustained the race-hatred of the native American towards his foreign conquerors, smouldering for centuries, now and then breaking out in furious revolt and civil war.

There is strong reason to suspect its power where, for obvious reasons, it has not been demonstrated. It has always been a mystery and a matter of surprise to the historians of Yucatan how rapidly spread the plans of the insurrection which secured lasting independence for the natives, after these plans had been agreed upon by the two chiefs, Antonio Ay and Cecilio Chi, at the remote rancho of Xihum, in July, 1847. Such unanimity of action could only have been possible through the aid of a powerful, well-disciplined and widespread secret organization. There can scarcely be a doubt they were the chiefs or masters of the redoubtable order of Nagualism in the Peninsula.‡

There is no question that such was the case with the brief and bloody revolt of the Mayas in 1761. It suddenly broke out in a number of villages near Valladolid, Yucatan, headed by a full-blood native, Jacinto Can-Ek; but some of the participants afterwards confessed that it was the outcome of a conspiracy which had been preparing for a year.

When the appointed day arrived, Jacinto boldly announced himself as the high priest of the fraternity of sorcerers, a master and teacher of magic, and the lineal successor of the famous

* "*Xochimilca*, que asi llamavan à los mui sabios encantadores." Torquemada, *Monarquia Indiana*, Lib. xv, cap. 16.

† In Nahuatl, *tlapiani*, a guardian or watchman. The Zapotec priesthood was divided into the *huijatoos*, "greater guardians," and their inferiors, the *copavitoos*, "guardians of the gods." Carriedo, *Estudios Historicòs*, p. 93.

‡ See Eligio Ancona, *Historia de Yucatan*, Tom. iv, cap. 1 (Mérida, 1880).

ancient prophet, Chilan Balam, "whose words cannot fail." In a stirring appeal he urged his fellow-countrymen to attack the Spaniards without fear of consequences.

"'Be not afraid,' he exclaimed, 'of their cannons and their forts; for among the many to whom I have taught the arts of magic (el arte de brujeria) there are fifteen chosen ones, marvelous experts, who by their mystic power will enter the fortress, slay the sentinels, and throw open the gates to our warriors. I shall take the leaves of the sacred tree, and folding them into trumpets, I shall call to the four winds of heaven, and a multitude of fighting men will hasten to our aid.'"*

Saying this, he took a sheet of paper, held it up to show that it was blank, folded it for a moment, and then spread it out covered with writing! This deft trick convinced his simple-minded hearers of the truth of his claims and they rushed to arms. He led them, clothed in the robe of the Virgin and with her crown on his head. But neither their enthusiasm nor their leader's art magic availed, and soon Jacinto and his followers fell victims to the stake and the gallows. After their death the dance of "the tiger," or of Chac-Mool—the "ghost dance" of the Mayas—was prohibited; and the use of the sacred drum—the favorite instrument of the native priests—was forbidden.†

In fact, wherever we have any full accounts of the revolts against the Spanish domination during the three centuries of its existence in New Spain, we can manifestly trace the guiding fingers of the powerful though hidden hand of Nagualism. An earlier revolt of the Mayas in Yucatan occurred in 1585. It was led by Andres Chi, a full-blood Indian, and a descendant of the ancient royal house of the Cocomes. He also announced himself as a priest of the ancient faith, a prophet and a worker of miracles, sent to instruct his own people in a new religion and to give them an independent political existence. Seized by

* The mention of the fifteen, 5 x 3, chosen disciples indicates that the same system of initiating by triplets prevailed in Yucatan as in Chiapas (see above, p. 27). The sacred tree is not named, but presumably it was the ceiba to which I refer elsewhere. The address of Jacinto was obtained from those present, and is given at length by the Jesuit Martin del Puerto, in his *Relacion hecho al Cabildo Eclesiastico por el preposito de la Compañia de Jesus, acerca de la muerte de Jacinto Can-Ek y socios*, Dec. 26, 1761. It is published, with other documents relating to this revolt, in the Appendix to the *Diccionario Universal*, edited by Orozco y Berra, Mexico, 1856. On the prophecies of Chilan Balam, see my *Essays of an Americanist*, pp. 255–273 (Philadelphia, 1890).

† Eligio Ancona, *Hist. de Yucatan*, Tom. ii, p. 452.

the Spaniards, he was charged with idolatry, sorcery and disturbing the peace, and was ignominiously hanged.*

Not less definitely inspired by the same ideas was the Mixe Indian, known as "Don Pascual," who led the revolt of the Tehuantepec tribes in 1661. He sent out his summons to the "thirteen governors of the Zapotecs and Chontales" to come to his aid, and the insurrection threatened to assume formidable proportions, prevented only by bringing to bear upon the natives the whole power of the Roman Church through the Bishop of Oaxaca, Cuevas Davalos.†

Nearly the same locality had been the scene of the revolt of the Zapotecs in 1550, when they were led by a native priest who claimed to be an incarnation of the old god Quetzalcoatl, the patron deity of the nagualists.‡

In the city of Mexico itself, in the year 1692, there was a violent outbreak of the natives, when they destroyed three million dollars worth of property. Doubtless this was partly attributable to the scarcity of food which prevailed; but that the authorities traced it also to some secret ceremonials is evident from the law which was immediately passed forbidding the Indians to wear the *piochtli*, or scalp-lock, a portion of the hair preserved from birth as part of the genethliac rituals,§ and the especial enactments against the *octli*.

As for the revolt of the Tzentals of Chiapas, in 1712, it was clearly and confessedly under the leadership of the nagualistic priesthood, as I shall indicate on a later page.

The history of the native American race under the Spanish power in North America has never yet been written with the slightest approach to thoroughness. He who properly qualifies

* See Pedro Sanchez de Aguilar, *Informe contra Idolum Cultores en Yucathan* (Madrid, 1639); Eligio Ancona, *Historia de Yucatan*, Tom. ii, pp. 128, 129.

† The chief authority on this revolt is Juan de Torres Castillo, *Relacion de lo Sucedido en las Provincias de Nexapa, Iztepex y Villa Alta* (Mexico, 1662). See also Cavo, *Los Tres Siglos de Mexico durante el Gobierno Español*, Tom. ii, p. 41, and a pamphlet by Christoval Manso de Contreras, *Relacion cierta y verdadera de lo que sucedio en esta Provincia de Tehuantepec*, etc. (printed at Mexico, 1661), which I know only through the notes of Dr. Berendt. Mr. H. H. Bancroft, in his very meagre account of this event, mistakingly insists that it took place in 1660. *History of Mexico*, Vol. iii, p. 161.

‡ See Brasseur de Bourbourg, *Histoire des Nations Civilisées de la Mexique*, Tom iv, 824.

§ Cavo, *Los Tres Siglos*, etc., Tom. ii, p. 82. On the use and significance of the *piochtli* we have some information in Vetancurt, *Teatro Mexicano*, Tom. ii, p. 464, and de la Serna, *Manual de Ministros*, pp. 166, 167. It was the badge of a certain order of the native priesthood.

himself for that task will certainly reach the conclusion expressed a number of years ago by the eminent American antiquary and historian, Mr. E. G. Squier, in these words :

"Among the ruling and priestly classes of the semi-civilized nations of America, there has always existed a mysterious bond, a secret organization, which all the disasters to which they have been subjected have not destroyed. It is to its present existence that we may attribute those simultaneous movements of the aborigines of Mexico and Central America, which have more than once threatened the complete subversion of the Spanish power."*

That mysterious bond, that secret organization, is *Nagualism.*

**20.** A remarkable feature in this mysterious society was the exalted position it assigned to Women. Not only were they admitted to the most esoteric degrees, but in repeated instances they occupied the very highest posts in the organization. According to the traditions of the Tzentals and Pipils of Chiapas, when their national hero, Votan, constructed by the breath of his mouth his darkened shrine at Tlazoaloyan, in Soconusco, he deposited in it the sacred books and holy relics, and constituted a college of venerable sages to be its guardians; but placed them all in subjection to a high priestess, whose powers were absolute.†

The veracious Pascual de Andagoya asserts from his own knowledge that some of these female adepts had attained the rare and peculiar power of being in two places at once, as much as a league and a half apart;‡ and the repeated references to them in the Spanish writings of the sixteenth and seventeenth centuries confirm the dread in which they were held and the extensive influence they were known to control. In the sacraments of Nagualism, Woman was the primate and hierophant.

**21.** This was a lineal inheritance from pre-Columbian times. In many native American legends, as in others from the old world, some powerful enchantress is remembered as the founder of the State, mistress of men through the potency of her magic powers.

* *Adventures on the Musquito Shore*, by S. A. Ward, pseudonym of Mr. Squier, p. 258 (New York, 1855).

† Nuñez de la Vega, *Constituciones Diocesanas*, p. 10, and comp. Brasseur de Bourbourg, *Hist. des Nat. Civ. de Mexique*, Tom. 1, p. 74.

‡ Herrera, *Hist. de las Indias Occidentales*, Dec. ii, Lib. iii, cap. 5.

Such, among the Aztecs, was the sorceress who built the city of Mallinalco, on the road from Mexico to Michoacan, famous even after the conquest for the skill of its magicians, who claimed descent from her.* Such, in Honduras, was Coamizagual, queen of Cerquin, versed in all occult science, who died not, but at the close of her earthly career rose to heaven in the form of a beautiful bird, amid the roll of thunder and the flash of lightning.†

According to an author intimately familiar with the Mexican nagualists, the art they claimed to possess of transforming themselves into the lower animals was taught their predecessors by a woman, a native Circe, a mighty enchantress, whose usual name was Quilaztli (the etymology of which is unknown), but who bore also four others, representing her four metamorphoses, Cohuacihuatl, the Serpent Woman; Quauhcihuatl, the Eagle Woman; Yaocihuatl, the Warrior Woman; and Tzitzimecihuatl, the Specter Woman.‡

The powers of these queens of magic extended widely among their sex. We read in the chronicles of ancient Mexico that when Nezahualpilli, the king, oppressed the tribes of the coast, the *tierra caliente*, they sent against him, not their warriors, but their witches. These cast upon him their fatal spells, so that when he walked forth from his palace, blood burst from his mouth, and he fell prone and dead.§

In Guatemala, as in ancient Delphos, the gods were believed to speak through the mouths of these inspired seeresses, and at the celebration of victories they enjoyed a privilege so strange and horrible that I quote it from the old manuscript before me without venturing a translation:

". . . . Despues de sacrificar los antiguos algun hombre, despedaçandolo, si era de los que avian cogido en guerra, dicen que guardaban el

* Acosta, *Hist. Nat. y Moral de las Indias*, Lib. vii, cap. 5.

† The story is given in Herrera, *Hist. de las Indias*, Dec. iv, Lib. viii, cap. 4. The name Coamizagual is translated in the account as "Flying Tigress." I cannot assign it this sense in any dialect.

‡ Jacinto de la Serna, *Manual de Ministros*, p. 138. Sahagun identifies Quilaztli with Tonantzin, the common mother of mankind and goddess of child-birth (*Hist. de Nueva España*, Lib. i, cap. 6, Lib. vi, cap. 27). Further particulars of her are related by Torquemada, *Monarquia Indiana*, Lib. ii, cap. 2. The *tzitzime* were mysterious elemental powers, who, the Nahuas believed, were destined finally to destroy the present world (Sahagun, l. c., Lib. vi, cap. 8). The word means "flying haired" (Serna).

§ Torquemada, *Monarquia Indiana*, Lib. ii, cap. 62.

miembro genital y los testiculos del tal sacrificado, y se los daban à una vieja que tenian por profeta, para que los comiese, y le pedian rogasse à su idolo les diesse mas captivos." *

When Captain Pedro de Alvarado, in the year 1524, was marching upon Quetzaltanango, in Guatemala, just such a fearful old witch took her stand at the summit of the pass, with her familiar in the shape of a dog, and "by spells and nagualistic incantations" undertook to prevent his approach.†

As in the earliest, so in the latest accounts. The last revolt of the Indians of Chiapas occurred among the Zotzils in 1869. The cause of it was the seizure and imprisonment by the Spanish authorities of a "mystical woman," known to the whites as Santa Rosa, who, together with one of their *ahaus* or chieftains, had been suspected of fomenting sedition. The natives marched thousands strong against the city of San Cristobal, where the prisoners were, and secured their liberation; but their leader, Ignacio Galindo, was entrapped and shot by the Spaniards, and the mutiny was soon quelled.‡

**22.** But perhaps the most striking instance is that recorded in the history of the insurrection of the Tzentals of Chiapas, in 1713. They were led by an Indian girl, a native Joan of Arc, fired by like enthusiasm to drive from her country the hated foreign oppressors, and to destroy every vestige of their presence. She was scarcely twenty years old, and was known to the Spaniards as Maria Candelaria. She was the leader of what most historians call a religious sect, but what Ordoñez y Aguiar, himself a native of Chiapas, recognizes as the powerful secret association of Nagualism, determined on the extirpation of the white race. He estimates that in Chiapas alone there were nearly seventy thousand natives under her orders—doubtless an exaggeration—and asserts that the conspiracy extended far into

* Fr. Tomas Coto, *Diccionario de la Lengua Cakchiquel*, MS., s. v. *Sacrificar;* in the Library of the American Philosophical Society at Philadelphia.

† "Trataron de valerse del arte de los encantos y *naguales*" are the words of the author, Fuentes y Guzman, in his *Recordacion Florida*, Tom. i, p. 50. In the account of Bernal Diaz, it reads as if this witch and her dog had both been sacrificed; but Fuentes is clear in his statement, and had other documents at hand.

‡ Teobert Maler, "Mémoire sur l'Etat de Chiapas," in the *Rèvue d' Ethnographie*, Tom. iii, pp. 309–311. This writer also gives some valuable facts about the Indian insurrection in the Sierra de Alicia, in 1873.

the neighboring tribes, who had been ordered to await the result of the effort in Chiapas.

Her authority was absolute, and she was merciless in requiring obedience to it. The disobedient were flayed alive or roasted over a slow fire. She and all her followers took particular pleasure in manifesting their hatred and contempt for the religion of their oppressors. They defiled the sacred vessels of the churches, imitated with buffoonery the ceremonies of the mass, which she herself performed, and stoned to death the priests whom they caught.

Of course, her attempt against the power of Spain was hopeless. It failed after a bitter and protracted conquest, characterized by the utmost inhumanity on both sides. But when her followers were scattered and killed, when the victorious whites had again in their hands all the power and resources of the country, not their most diligent search, nor the temptation of any reward, enabled them to capture Maria Candelaria, the heroine of the bloody drama. With a few trusty followers she escaped to the forest, and was never again heard of.*

More unfortunate were her friends and lieutenants, the priestesses of Guistiupan and Yajalon, who had valiantly seconded Maria in her patriotic endeavors. Seized by the Spaniards, they met the fate which we can easily imagine, though the historian has mercifully thrown a veil on its details.†

**23.** Of just such a youthful prophetess did Mr. E. G. Squier hear during his travels in Central America, a "*sukia* woman," as she was called by the coast Indians, one who lived alone mid the ruins of an old Maya temple, a sorceress of twenty years, loved and feared, holding death and life in her hands.‡ Per-

* The long account given by Mr. H. H. Bancroft of this insurrection is a travesty of the situation drawn from bitterly prejudiced Spanish sources, of course, utterly out of sympathy with the motives which prompted the native actors. See his *History of the Pacific States*, Vol. ii, p. 696, *sqq.* Ordoñez y Aguiar, who lived on the spot within a generation of the occurrences, recognizes in Maria Candelaria (whose true name Bancroft does not give) the real head of the rebellion, "quien ordenaba los ardides del motin; . . . . de lo que principalmente trataban las leyes fundamentales de su secta, era de que no quedase rastro alguno de que los Europeos havian pisado este suelo." His account is in his unpublished work, *Historia del Cielo y de la Tierra*, written at Guatemala about 1780. Juarros, speaking of their rites, says of them: "Apostando de la fé, profanando los vasos sagrados, y ofreciendo sacrilegos cultos á una indizuela." *Historia de la Ciudad de Guatemala*, Tom. i, p. 17.

† Bancroft, ubi suprà, p. 705, note. One was hanged, whom Garcia Pelaez calls "una india bruja." *Memorias para la Historia de Guatemala*, Tom. ii, p. 153.

‡ Squier, ubi suprà, passim.

haps his account is somewhat fanciful; it is so, indeed; but it is grounded on the unshaken beliefs and ancient traditions of the natives of those climes, and on customs well known to those who reside there.

The late distinguished Americanist, the Abbé Brasseur de Bourbourg, during his long travels in Mexico and Central America, had occasion more than once to come in contact with this trait of the ancient faith of the Nagualists, still alive in their descendants. Among the Zapotecs of the Isthmus of Tehuantepec he saw one of the queens of the mystic fraternity, and he describes her with a warmth which proves that he had not lost his eye for the beautiful.

"She wore a piece of light-green stuff loosely folded around her form at the hips, and falling to a little distance above the ankle; a jacket of red silk gauze with short sleeves and embroidered with gold, clothed the upper part of her person, veiling her bosom, upon which lay a chain of heavy gold pieces, pierced and strung on a cord. Her rich black hair was divided on the forehead, and drawn back in two splendid tresses fastened with blue ribbons, while a white muslin kerchief encircled her head like the calantica of the ancient Egyptians. Never in my life have I seen a more striking figure of an Isis or a Cleopatra.

"There was something strange in her expression. Her eyes were the blackest and the brightest in the world; but there were moments when she suddenly paused, leaned against the billiard table or the wall, and they became fixed and dead like those of a corpse. Then a fiery glance would shoot from beneath her dark lashes, sending a chill to the heart of the one to whom it was directed. Was it madness, or was it, as those around her believed, a momentary absence of soul, an absorption of her spirit into its *nagual*, a transportation into an unknown world? Who shall decide?"*

**24.** It would be a mistake to suppose that Nagualism was an incoherent medley of superstitions, a mass of jumbled fragments derived from the ancient paganism. My study of it has led me to a widely different conclusion. It was a perpetuation of a well-defined portion of the native cult, whose sources we are able to trace long anterior to the period of the conquest, and which had no connection with the elaborate and bloody ritual of the Aztecs. The evidence to this effect is cogent.

Wherever in later days the Catholic priests found out the

* *Voyage à l'Isthmus de Tehuantepec*, p. 164. He adds a number of particulars of the power she was supposed to exercise.

holy places and sacred objects of the nagualists, they were in-caves or deep rock-recesses, not in artificial structures. The myths they gleaned, and the names of the gods they heard, also point to this as a distinguishing peculiarity. An early instance is recorded among the Nahuas of Mexico. In 1537 Father Perea discovered a cavern in a deep ravine at Chalma, near Mallinalco (a town famous for its magicians), which was the sanctuary of the deity called *Oztoteotl*, the Cave God (*oztotl*, cave; *teotl*, god), "venerated throughout the whole empire of Montezuma."* He destroyed the image of the god, and converted the cavern into a chapel.

We cannot err in regarding Oztoteotl as merely another name of the Nahuatl divinity, Tepeyollotl, the Heart, or Inside, of the Mountain, who in the Codex Borgia and the Codex Vaticanus is represented seated upon or in a cavern. His name may equally well be translated "the Heart of the Place," or "of the Town."

Dr. Eduard Seler has shown beyond reasonable question that this divinity did not originally belong to the Aztec Pantheon, but was introduced from the South, either from the Zapotecs, the Mixtecs, or the Mayan tribes, beyond these.† The Cave God of the Aztecs is identical with the Votan of the Tzentals of Chiapas, and with the U-q'ux Uleuh of the Quiches of Guatemala, and probably with the Cozaana of the Zapotecs.

The rites of all of these were conducted in caverns, and there have been preserved several interesting descriptions of the contents of these sacred places. That relating to the "dark house of Votan" is given thus in the work of the Bishop of Chiapas:

> "Votan is the third hero who is named in the calendar, and some of his descendants still reside in the town of Teopisca, where they are known as Votans. He is sometimes referred to as Lord of the Sacred Drum, and he is said to have seen the great wall (which must have been the Tower of Babel), and to have divided this land among the Indians, and given to each tribe its language.

* "Que era venerado en todo el imperio de Montezuma." See *Diccionario Universal*, Appendice, s. v. (Mexico, 1856).

† "Dass der Gott Tepeyollotl im Zapotekenlande und weiter südwärts seine Wurzeln hat, und dem eigentlichen Aztekischen Olymp fremd ist, darüber kann kein Zweifel mehr obwalten." See Dr. Seler's able discussion of the subject in the *Compte-Rendu* of the Seventh International Congress of Americanists, p. 559, *seq.* The adoption of subterranean temples was peculiarly a Zapotecan trait. "Notandose principalmente en muchos adoratorios de los Zapotecos, estan los mas de ellos cubiertos, ò en subterraneos espaciosos y lòbregos." Carriedo, *Estudios Historicos*, Tom. i, p. 26.

"They say further that he once dwelt in Huehuetan, a town in the province of Soconusco. Near there, at the place called Tlazoaloyan, he constructed, by blowing with his breath, a dark house, and put tapirs in the river, and in the house a great treasure, and left all in charge of a noble lady, assisted by guardians (*tlapiane*) to preserve. This treasure consisted of earthenware vases with covers of the same material; a stone, on which were inscribed the figures of the ancient native heroes as found in the calendar; *chalchiuites*, which are green stones; and other superstitious objects.

"All of these were taken from the cave, and publicly burned in the plaza of Huehuetan on the occasion of our first diocesan visit there in 1691, having been delivered to us by the lady in charge and the guardians. All the Indians have great respect for this Votan, and in some places they call him 'the Heart of the Towns.'"*

The English priest, Thomas Gage, who was curate of a parish among the Pokonchi Indians of Guatemala about 1630, relates his discovery of such a cave, in which the idol was preserved, and gives this description of it:

"We found the Idol standing upon a low stool covered with a linen cloth. The substance of it was wood, black shining like jet, as if it had been painted or smoked; the form was of a man's head unto the shoulders, without either Beard or Mustachoes; his look was grim, with a wrinkled forehead, and broad staring eyes.

"They boasted of this their god, saying that he had plainly told them they should not believe anything I preached of Christ, but follow the old ways of their forefathers."†

The black color here mentioned was a relic of ancient symbolism, referring to the night, darkness, and the obscurity of the holy cavern. Vetancurt informs us that the priests of the ancient paganism were accustomed to rub their faces and bodies with an ointment of fat and pine soot when they went to sacrifice in the forests, so that they looked as black as negroes ‡ In the extract from Nuñez de la Vega already given, *Ical Ahau*, the "Black King," is named as one of the divinities of the nagualists.

In some parts the principal idol found in the caves was the

* *Constituciones Diocesanas*, pp. 9, 10.

† Gage, *A New Survey of the West Indies*, pp. 339, 393.

‡ *Teatro Mexicano*, Tratado iii, cap. 11. Mr. Bandelier has called attention to the naming of one of the principal chiefs among the Aztecs, *Tlilancalqui*, "Man of the Dark House," and thinks it related to the Votan myth. *Twelfth Annual Report of the Peabody Museum*, p. 689.

mummied or exsiccated body of some former distinguished priest or chieftain. One such is recorded by Bartholomé de Pisa, which was found among the Zapotecs of Coatlan. It bore a name taken from the calendar, that of the tenth day, and was alleged to be the preserved cadaver of a celebrated ruler.* Another interesting example is narrated by Villa Señor y Sanchez,† who describes it as an eye-witness. It was discovered in a spacious cave located some distance to the west of the city of Mexico, in Nahuatl territory, on the side of what was known as "the Sun mountain"—*la Mesa de Tonati*. He speaks of it as remarkably well preserved, "both the muscles and the bones."

"It was seated in an armchair which served for a throne, and was clothed in a mantle, which fell from the shoulders to the feet. This was richly adorned with precious stones, which, according to the native custom, were sewed into the texture of the cloth. The figure also wore shoulder straps, collars, bracelets and fastenings of silver. From its forehead rose a crown of beautiful feathers of different colors. arranged so that one color should alternate with another. The left hand was resting on the arm of the chair, while in the right was a sharp cutlass with silver mountings. At its feet were several vases of fine stone, as marble and alabaster, in which were offerings of blood and meat, obtained from the sacrifices."

The same writer refers to other examples of these sacred caves which he had seen in his journeys. One was near the town of Teremendo, where the sides and roof had been artificially dressed into the shape of huge arches. A natural altar had been provided in a similar manner, and on it, at the time of his visit, were numerous idols in the figures of men and animals, and before them fresh offerings of copal and food. Elsewhere he refers to many such caverns still in use as places resorted to by the natives in *la gran Sierra de Tlascala*.‡

These extracts prove the extent of this peculiar worship and the number of these subterranean temples in recent generations. The fame of some of the greater ones of the past still survives, as the vast grotto of Chalcatongo, near Achiutla, which was the sepulchral vault of its ancient kings; that of Totomachiapa, a

* Herrera, *Historia de las Indias Occidentales*, Dec. iii, Lib. iii, cap. 14.

† Villa Señor, *Teatro Americano*, Lib. v, cap. 38 (Mexico, 1747). Father Cavo adds that there were signs of human sacrifices present, but of this I can find no evidence in the earlier reports. Comp. Cavo, *Los Tres Siglos de Mexico durante el Gobierno Español*, Tom. ii, p. 128.

‡ *Teatro Americano*, Lib. ii, cap. 11; Lib. iii, cap. 13.

solemn scene of sacrifice for the ancient priests; that of Justlahuaca, near Sola (Oaxaca), which was a place of worship of the Zapotecs long after the Conquest; and that in the Cerro de Monopostiac, near San Francisco del Mar.*

The intimate meaning of this cave-cult was the worship of the Earth. The Cave God, the Heart of the Hills, really typified the Earth, the Soil, from whose dark recesses flow the limpid streams and spring the tender shoots of the food-plants, as well as the great trees. To the native Mexican, the Earth was the provider of food and drink, the common Father of All; so that to this day, when he would take a solemn oath, he stoops to the earth, touches it with his hand, and repeats the solemn formula: *Cuix amo nechitla in toteotzin?* "Does not our Great God see me?"

**25.** The identity of the Tepeyollotl of the Nahuas and the Votan of the Tzentals is shown not only in the oneness of meaning of the names, but in the fact that both represent the *third* day in the ritual calendar. For this reason I take it, we find the number *three* so generally a sacred number in the symbolism of the nagualists. We have already learned in the extract from Nuñez de la Vega that the neophytes were instructed in classes of three. To this day in Soteapan the fasts and festivals appointed by the native ministrants are three days in duration.† The semi-Christianized inhabitants of the Sierra of Nayerit, the Nahuatl-speaking Chotas, continued in the last century to venerate three divinities, the Dawn, the Stone and the Serpent;‡ analogous to a similar "trinity" noted by Father Duran among the ancient Aztecs.§

The number *nine*, that is, 3 x 3, recurs so frequently in the conjuration formulas of the Mexican sorcerers that de la Serna exclaims: "It was the Devil himself who inculcated into them this superstition about the number nine."‖

* See Mühlenpfordt, *Mexico*, Bd. ii, pp. 200–266; Brasseur, *Hist. des Nations Civ. de la Mexique*, Vol. iv, p. 821; Herrera, *Historia de las Indias*, Dec. iii, Lib. iii, cap. 12, etc.

† *Diccionario Universal*, Appendice, s. v.

‡ Their names were Ta Yoapa, Father Dawn; Ta Te, Father Stone; Coanamoa, the Serpent which Seizes. *Dicc. Univ.*, App., Tom. iii, p. 11.

§ Duran, *Historia de los Indios*, Tom. ii, p. 140. They were Tota, Our Father; Yollometli, the Heart of the Maguey (probably pulque); and Topiltzin, Our Noble One (probably Quetzalcoatl, to whom this epithet was often applied).

‖ "Fue el Demonio que les dió la superstición del numero nueve." *Manual de Ministros*, p. 197.

The other number sacred to the nagualists was *seven*. I have, in a former essay, given various reasons for believing that this was not derived from the seven days of the Christian week, but directly from the native calendar. * Nuñez de la Vega tells us that the patron of the seventh day was *Cuculcan*, "the Feathered Serpent," and that many nagualists chose him as their special protector. As already seen, in Guatemala the child finally accepted its *naual* when seven years old; and among some of the Nahuatl tribes of Mexico the *tonal* and the calendar name was formally assigned on the seventh day after birth.† From similar impressions the Cakchiquels of Guatemala maintained that when the lightning strikes the earth the "thunder stone" sinks into the soil, but rises to the surface after seven years. ‡

The three and the seven were the ruling numbers in the genealogical trees of the Pipiles of San Salvador. The "tree" was painted with *seven* branches representing degrees of relationship within which marriage was forbidden unless a man had performed some distinguished exploit in war, when he could marry beyond the nearest *three* degrees of relationship.§ Another combination of 3 and 7, by multiplication, explains the customs among the Mixes of deserting for 21 days a house in which a death has occurred. ||

The indications are that the nagualists derived these numbers from the third and seventh days of the calendar "month" of twenty days. Tepeololtec, the Cave God, was patron of the third day and also "Lord of Animals," the transformation into which was the test of nagualistic power.¶ Tlaloc, god of the mountains and the rains, to whom the seventh day was hallowed, was represented by the nagualistic symbol of a snake doubled and twisted on itself, and was generally portrayed in connection with the "Feathered Serpent" (Quetzalcoatl, Cuculchan, Gukumatz, all names meaning this), represented as carrying his medicine bag, *xiquipilli*, and incensory, the apparatus of the

* *The Native Calendar of Central America and Mexico*, p. 12.

† Motolinia, *Ritos Antiguos, Sacrificios e Idolatrias de los Indios de la Nueva España*, p. 340 (in *Coleccion de Documentos ineditos para la Historia de España*).

‡ Thomas Coto, *Vocabulario de la lengua Cakchiquel*, MS., sub voce, *Rayo*.

§ Herrera, *Historia de las Indias*, Dec. iv, Lib. viii, cap. 10.

|| *Diccionario Universal*, Appendice, ubi suprá.

¶ "Señor de los Animales." *Codex Telleriano-Remensis*, Parte ii, Lam. iv.

native illuminati, his robe marked with the sign of the cross to show that he was Lord of the Four Winds and of Life. *

**26.** The nagualistic rites were highly symbolic, and the symbols used had clearly defined meanings, which enable us to analyze the religious ideas underlying this mysterious cult.

The most important symbol was Fire. It was regarded as the primal element and the immediate source of life. Father Nicolas de Leon has the following suggestive passage in this connection:

"If any of their old superstitions has remained more deeply rooted than another in the hearts of these Indians, both men and women, it is this about fire and its worship, and about making new fire and preserving it for a year in secret places. We should be on the watch for this, and when in their confessions they speak of what the Fire said and how the Fire wept, expressions which we are apt to pass by as unintelligible, we must lay our hands on them for reprehension. We should also be on the watch for their baptism by Fire, a ceremony called the *yiahuiltoca*,† shortly after the birth of a child when they bestow on it the surnames; nor must the lying-in women and their assistants be permitted to speak of Fire as the father and mother of all things and the author of nature; because it is a common saying with them that Fire is present at the birth and death of every creature."

This curious ceremony derived its name from the *yiahuitli*, a plant not unlike the absinthe, the powdered leaves of which, according to Father Sahagun, the natives were accustomed to throw into the flames as an offering to the fire.‡ Long after the conquest, and probably to this day, the same custom prevails in Mexico, the fumes and odor of the burning leaves being considered very salubrious and purifying to the air of the sick room §

* See Dr. Seler's minute description in the *Compte Rendu* of the Eighth Session of the Congrés International des Américanistes, pp. 588, 589. In one of the conjuration formulas given by de la Serna (*Manual de Ministros*, p. 212) the priest says: "Yo soy el sacerdote, el dios *Quetzalcoatl*, que se bajará al infierno, y subiré á lo superior, y hasta los nueve infiernos." This writer, who was very competent in the Nahuatl, translates the name Quetzalcoatl by "culebra con cresta" (*id.*, p. 171), an unusual, but perhaps a correct rendering.

† His words here are somewhat obscure. They are, "El baptismo de fuego, en donde las ponen los sobre nombres que llaman *yahuiltoca*, quando nacen." This may be translated, "The baptism of fire in which they confer the names which they call *yahuiltoca*." The obscurity is in the Nahuatl, as the word *toca* may be a plural of *tocaitl*, name, as well as the verb *toca*, to throw upon. The passage is from the *Camino del Cielo*, fol. 100, verso.

‡ Sahagun, *Historia de la Nueva España*, Lib. iv, cap. 25.

§ It is mentioned as useful for this purpose by the early physicians, Francisco Ximenes, *Cuatro Libros de la Naturaleza*, p. 144; Hernandez, *Hist. Plant. Novæ Hispaniæ*, Tom.

The word *yiahuiltoca* means "the throwing of the *yiauhtli*" (from *toca*, to throw upon with the hands). Another name for the ceremony, according to Father Vetancurt, who wrote a century later than Leon, was *apehualco*, which has substantially the same meaning, "a throwing upon" or "a throwing away." * He adds the interesting particulars that it was celebrated on the fourth day after the birth of the child, during which time it was deemed essential to keep the fire burning in the house, but not to permit any of it to be carried out, as that would bring bad luck to the child.

Jacinto de la Serna also describes this ceremony, to which he gives the name *tlecuixtliliztli*, "which means that they pass the infant over the fire;" and elsewhere he adds: "The worship of fire is the greatest stumbling-block to these wretched idolaters."†

**27.** Other ceremonies connected with fire worship took place in connection with the manufacture of the pulque, or *octli*, the fermented liquor obtained from the sap of the maguey plant. The writer just quoted, de Vetancurt, states that the natives in his day, when they had brewed the new pulque and it was ready to be drunk, first built a fire, walked in procession around it and threw some of the new liquor into the flames, chanting the while an invocation to the god of inebriation, Tezcatzoncatl, to descend and be present with them.

This was distinctly a survival of an ancient doctrine which connected the God of Fire with the Gods of Drunkenness, as we may gather from the following quotation from the history composed by Father Diego Duran:

"The *octli* was a favorite offering to the gods, and especially to the God of Fire. Sometimes it was placed before a fire in vases, sometimes

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ii, p. 200. Capt. Bourke, in his recent article on "The Medicine Men of the Apaches" (in *Ninth Annual Report of the Bureau of Ethnology*, p. 521), suggests that the *yiahuitli* of the Aztecs is the same as the "hoddentin," the pollen of a variety of cat-tail rush which the Apaches in a similar manner throw into the fire as an offering. Hernandez, however, describes the *yiahuitli* as a plant with red flowers, growing on mountains and hill-sides—no species of rush, therefore. De la Serna says it is the anise plant, and that with it the natives perform the conjuration of the "yellow spirit" (conjuro de amarillo espiritado), that is, of the Fire (*Manual de Ministros*, p. 197).

* From the verb *apeua*. Vetancurt's description is in his *Teatro Mexicano*, Tom. i, pp. 462, 463 (Ed. Mexico, 1870).

† His frequent references to it show this. See his *Manual de Ministros*, pp. 16, 20, 22, 24, 36, 40, 66, 174, 217, etc. The word *tlecuixtliliztli* is compounded of *tlecuilli*, the hearth or fireplace, and *ixtliluia*, to darken with smoke.

it was scattered upon the flames with a brush, at other times it was poured out around the fireplace."*

**28.** The high importance of the fire ceremonies in the secret rituals of the modern Mayas is plainly evident from the native Calendars, although their signification has eluded the researches of students, even of the laborious Pio Perez, who was so intimately acquainted with their language and customs. In these Calendars the fire-priest is constantly referred to as *ah-toc*, literally "the fire-master." The rites he celebrates recur at regular intervals of twenty days (the length of one native month) apart. They are four in number. On the first he takes the fire; on the second he kindles the fire; on the third he gives it free play, and on the fourth he extinguishes it. A period of five days is then allowed to elapse, when these ceremonies are recommenced in the same order. Whatever their meaning, they are so important that in the *Buk Xoc*, or General Computation of the Calendar, preserved in the mystic "Books of Chilan Balam," there are special directions for these fire-masters to reckon the proper periods for the exercise of their strange functions.†

**29.** What, now, was the sentiment which underlay this worship of fire? I think that the facts quoted, and especially the words of Father de Leon, leave no doubt about it. Fire was worshiped as the life-giver, the active generator, of animate existence. This idea was by no means peculiar to them. It repeatedly recurs in Sanskrit, in Greek and in Teutonic mythology, as has been ably pointed out by Dr. Hermann Cohen.‡ The fire-god Agni (*ignis*) is in the Vedas the Maker of men; Prometheus steals the fire from heaven that he may with it animate the human forms he has moulded of clay; even the connection of the pulque with the fire is paralleled in Greek mythos, where Dionysos is called *Pyrigenes*, the "fire-born."

Among the ancient Aztecs the god of fire was called the

* Duran, *Historia de los Indios de la Nueva España*, Tom. ii, p. 210. Sahagun adds that the *octli* was poured on the hearth at four separate points, doubtless the four cardinal points. *Historia de Nueva España*, Lib. i, cap. 13. De la Serna describes the same ceremony as current in his day, *Manual de Ministros*, p. 35. The invocation ran :—"Shining Rose, light-giving Rose, receive and rejoice my heart before the God."

† A copy of these strange "Books of Chilan Balam" is in my possession. I have described them in my *Essays of an Americanist* (Philadelphia, 1890).

‡ See his remarks on "Apperception der Menschenzeugung als Feuerbereitung," in the *Zeitschrift für Völkerpsychologie*, Bd. vi, s. 113, *seq.*

oldest of gods, *Huehueteotl*, and also "Our Father," *Tota*, as it was believed from him all things were derived.* Both among them and the Mayas, as I have pointed out in a previous work, he was supposed to govern the generative proclivities and the sexual relations. † Another of his names was *Xiuhtecutli*, which can be translated "God of the Green Leaf," that is, of vegetable fecundity and productiveness. ‡

To transform themselves into a globe or ball of fire was, as we have seen (antè, p. 29), a power claimed by expert nagualists, and to handle it with impunity, or to blow it from the mouth, was one of their commonest exhibitions. Nothing so much proved their superiority as thus to master this potent element.

**30.** The same name above referred to, "the Heart of the Town," or "of the Hills," was that which at a comparatively late date was applied to an idol of green stone preserved with religious care in a cavern in the Cerro de Monopostiac, not far from San Francisco del Mar. The spot is still believed by the natives to be enchanted ground and protected by superhuman powers. §

These green stones, called *chalchiuitl*, of jadeite, nephrite, green quartz, or the like, were accounted of peculiar religious significance throughout southern Mexico, and probably to this day many are preserved among the indigenous population as amulets and charms. They were often carved into images, either in human form or representing a frog, the latter apparently the symbol of the waters and of fertility. Bartholomè de Alva refers to them in a passage of his Confessionary. The priest asks the penitent:

"Dost thou possess at this very time little idols of green stone, or frogs made of it (*in chalchiuh coconeme, chalchiuh tamazoltin*)?

"Dost thou put them out in the sun to be warmed? Dost thou keep them wrapped in cotton coverings, with great respect and veneration?

"Dost thou believe, and hold for very truth, that these green stones give thee food and drink, even as thy ancestors believed, who died in their idolatry? Dost thou believe that they give thee success and prosperity

* Sahagun, *Historia de Nueva España*, Lib. i, cap. 13. The Nahuatl text is more definite than the Spanish translation.

† See my *Myths of the New World*, p. 154, *seq.*

‡ In the Nahuatl language the word *xihuitl* (*xiuitl*) has four meanings: a plant, a turquoise, a year and a comet.

§ J. B. Carriedo, *Estudios Historicos del Estado Oaxaqueño*, Tom. i, p. 82, etc.

**and good things, and all that thou hast or wishest? Because we know very well that many of you so believe at this very time."** *

Down to quite a recent date, and perhaps still, these green stones are employed in certain ceremonies in vogue among the Indians of Oaxaca in order to ensure a plenteous maize harvest. The largest ear of corn in the field is selected and wrapped up in a cloth with some of these chalchiuite. At the next corn-planting it is taken to the field and buried in the soil. This is believed to be a relic of the worship of the ancient Zapotec divinity, Quiegolani, who presided over cultivated fields.†

They are still in use among the natives as lucky stones or amulets. In the Zotzil insurrection of 1869, already referred to, one was found suspended to the neck of one of the slain Indians. It came into the possession of M. Maler, who has described and figured it.‡ It represents a human head with a curious expression and a singular headdress.

From specimens of these amulets preserved in museums it is seen that any greenish stone was selected, preferably those yielding a high, vitreous polish, as jadeite, turquoise, emerald, chlormelanite or precious serpentine. The color gave the sacred character, and this, it seems to me, was distinctly meant to be symbolic of water and its effects, the green of growing plants, and hence of fertility, abundance and prosperity.

**31.** There is another symbol, still venerated among the present indigenous population, which belongs to Nagualism, and is a survival from the ancient cult; this is the Tree. The species held in especial respect is the ceiba, the silk-cotton tree, the *ytzamatl* (knife-leaved paper tree) of the Nahuas, the *yax che* (green, or first tree) of the Mayas, the *Bombax ceiba* of the botanists. It is of great size and rapid growth. In Southern Mexico and Central America one is to be seen near many of the native villages, and is regarded as in some way the protecting genius of the town.

Sacred trees were familiar to the old Mexican cult, and, what is curious, the same name was applied to such as to the fire,

* Alva, *Confessionario en Lengua Mexicana*, fol. 9.

† Carriedo, *Estudios Historicos*, pp. 6, 7.

‡ In the *Revue d'Ethnographie*, Tom. iii, p. 313. Some very fine objects of this class are described by E. G. Squier, in his "Observations on the Chalchihuitl," in the *Annals of the Lyceum of Natural History*, Vol. i (New York, 1869).

*Tota*, Our Father. They are said to have represented the gods of woods and waters.* In the ancient mythology we often hear of the "tree of life," represented to have four branches, each sacred to one of the four cardinal points and the divinities associated therewith.

The conventionalized form of this tree in the Mexican figurative paintings strongly resembles a cross. Examples of it are numerous and unmistakable, as, for instance, the cruciform tree of life rising from a head with a protruding tongue, in the Vienna Codex.†

**32.** Thus, the sign of the cross, either the form with equal arms known as the cross of St. Andrew, which is the oldest Christian form, or the Latin cross, with its arms of unequal length, came to be the ideogram for "life" in the Mexican hieroglyphic writing; and as such, with more or less variants, was employed to signify the *tonalli* or *nagual*, the sign of nativity, the natal day, the personal spirit.‡ The ancient document called the Mappe Quinatzin offers examples, and its meaning is explained by various early writers. The peculiar character of the Mexican ritual calendar, by which nativities were calculated, favored a plan of representing them in the shape of a cross; as we see in the singular *Codex Cruciformis* of the Boturini-Goupil collection.

**33.** But the doctrines of Nagualism had a phase even more detestable to the missionaries than any of these, an esoteric phase, which brought it into relation to the libidinous cults of Babylon and the orgies of the "Witches' Sabbaths" of the Dark Ages. Of these occult practices we of course have no detailed descriptions, but there are hints and half-glances which leave us in no doubt.

When the mysterious metamorphosis of the individual into his or her *nagual* was about to take place, the person must

* Diego Duran, *Historia de los Indios de Nueva España*, Tom. ii, p. 140.

† In Kingsborough, *Antiquities of Mexico*, Vol. ii, Pl. 180. On the cross as a form derived from a tree see the observations of W. H. Holmes, in the *Second Annual Report of the Bureau of Ethnology*, pp. 270, 271.

‡ "Au Mexique, le cadre croisé, la croix en santoir, comme celle de St. André, avec quelques variantes, representait le signe de nativité, *tonalli*, la fête, le jour natal." M. Aubin, in Boban, *Catalogue Raisonnée de la Collection Goupil*, Tom. i, p. 227. Both Gomara and Herrera may be quoted to this effect.

strip to absolute nudity;* and the lascivious fury of bands of naked Nagualists, meeting in remote glades by starlight or in the dark recesses of caves, dancing before the statues of the ancient gods, were scenes that stirred the fanaticism of the Spanish missionaries to its highest pitch. Bishop Landa informs us that in Yucatan the dance there known as the *naual* was one of the few in which both men and women took part, and that it "was not very decent." It was afterwards prohibited by the priests. We have excellent authority that such wild rites continued well into the present century, close to the leading cities of the State,† and it is highly likely that they are not unknown to-day.

**34.** Moreover, it is certain that among the Nagualists, one of their most revered symbols was the *serpent;* in Chiapas, one of their highest orders of the initiated was that of the *chanes*, or serpents. Not only is this in Christian symbolism the form and sign of the Prince of Evil and the enemy of God, but the missionaries were aware that in the astrological symbols of ancient Mexico the serpent represented the *phallus;* that it was regarded as the most potent of all the signs; ‡ and modern research has shown, contrary to the opinion long held, that there was among these nations an extraordinary and extensive worship of the reciprocal principle of nature, associated with numerous phallic emblems.§

Huge phalli of stone have been discovered, one, for instance, on the Cerro de las Navajas, not far from the city of Mexico,

* See a curious story from native sources in my *Essays of an Americanist*, pp. 171, 172. It adds that this change can be prevented by casting salt upon the person.

† Benito Maria de Moxo, *Cartas Mejicanas*, p. 257; Landa, *Cosas de Yucatan*, p. 193.

‡ Pedro de los Rios, in his notes to the Codex Vaticanus, published in Kingsborough's great work, assigns the sign, *cohuatl*, the serpent, to "il membro virile, il maggio augurio di tutti gli altri." It is distinctly so shown on the 75th plate of the Codex. De la Serna states that in his day some of the Mexican conjurors used a wand, around which was fastened a living serpent. *Manual de Ministros*, p. 37.

§ There is abundant evidence of this in certain plates of the Codex Troano, and there is also alleged to be much in the Codex Mexicanus of the Palais Bourbon. Writing about the latter, M. Aubin said as far back as 1841—"le culte du lingam on du phallus n'etait pas etranger aux Mexicains, ce qu' etablissent plusieurs documents peu connus et des sculptures découvertes depuis un petit nombre d'années." His letter is in Boban, *Catalogue Raisonné de la Collection Goupil*, Tom. ii, p. 207. On the frequent identification of the serpent symbol with the phallus in classical art, consult Dr. Anton Nagele's article, "Der Schlangen-Cultus," in the *Zeitschrift für Völkerpsychologie*, Band xvii, p. 285, *seq.*

and another in the State of Hidalgo.* Probably they were used in some such ceremonies as Oviedo describes among the Nahuas of Nicaragua, where the same symbol was represented by conical mounds of earth, around which at certain seasons the women danced with libidinous actions. Although as a general rule the pottery of ancient Mexico avoids obscenity, Brasseur stated that he had seen many specimens of a contrary character from certain regions,† and Dr. Berendt has copied several striking examples, showing curious *yoni* symbols, which are now in my possession.

We may explain these as in some way connected with the worship of Pantecatl, the male divinity who presided over profligate love, and of Tlazolteotl, the *Venus Impudica* of the Aztec pantheon; and it is not without significance that the cave-temple of Votan, whose contents were destroyed by the Bishop of Chiapas, in 1691 (see above, p. 47), was located at *Tlazoaloyan*, both names being derived from a root signifying sexual action.‡ The other name of the divinity, called "the Heart of the Hills," is in Quiche, Alom, "he who begets," and the Zapotec Cozaana, another analogue of the same deity, is translated by Seler, "the Begetter." Such facts indicate how intimately the esoteric doctrines of Nagualism were related to the worship of the reproductive powers of nature.

**35.** It will readily be understood from what has been said that Nagualism was neither a pure descendant of the ancient cults, nor yet a derivative from Christian doctrines and European superstitions. It was a strange commingling of both, often in grotesque and absurd forms. In fact, the pretended Christianity of the native population of Mexico to-day is little more than a figment, according to the testimony of the most competent observers.§

The rituals and prayers of the nagualists bear witness to this. It is very visible in those I have quoted from Nuñez de

* Cf. G. Tarayre, *Exploration Mineralogique des Regions Mexicaines*, p. 233 (Paris, 1869), and *Bulletin de la Société d'Anthropologie de Paris*, Juin, 1893.

† *Sources de l'Histoire Primitive de Mexique*, p. 81.

‡ From *zo*, to join together. Compare my *Essays of an Americanist*, p. 417 (Philadelphia, 1890).

§ "El indio Mexicano es todavia idolatra." F. Pimentel, *La Situacion actual de la Raza Indigena de Mexico*, p. 197.

la Vega, and I can add an interesting example of it which has not heretofore been published. I take it from the MSS. of Father Vicente Hernandez Spina, cura of Ixtlavacan, in Guatemala, a remote village of the Quiches. He wrote it down in the native tongue about forty years ago, as recited by an *ah-kih*, "reader of days," a native master of the genethliac art, who had composed it in favor of a client who had asked his intercession.

*Prayer of an Ah-Kih.*

"O Jesus Christ my God: thou God the Son, with the Father and the Holy Spirit, art my only God. To-day, on this day, at this hour, on this day Tibax, I call upon the holy souls which accompany the sun-rising and the sun-setting of the day: with these holy souls I call upon thee, O chief of the genii, thou who dwellest in this mountain of Siba Raxquin; come, ye holy spirits of Juan Vachiac, of Don Domingo Vachiac, of Juan Ixquiaptap, the holy souls of Francisco Excoquieh, of Diego Soom, of Juan Fay, of Alonzo Tzep; I call the holy souls of Diego Tziquin and of Don Pedro Noh: you, O priests, to whom all things are revealed, and thou, chief of the genii, you, lords of the mountains, lords of the plains, thou, Don Purupeto Martin, come, accept this incense, accept to-day this candle.*

"Come also, my mother Holy Mary, the Lord of Esquipulas, the Lord of Capetagua, the beloved Mary of Chiantla, with her who dwells at San Lorenzo, and also Mary of Sorrows, Mary Saint Anna, Mary Tibureia, Mary of Carmen, with Saint Michael the Archangel, the captain St. James, St. Christoval, St. Sebastian, St. Nicolas, St. Bonaventura, St. Bernardin, St. Andrew, St. Thomas, St. Bartholomew, and thou my beloved mother St. Catherine, thou beloved Mary of the Conception, Mary of the Rosary, thou lord and king Pascual, be here present.

"And thou, Frost, and thou, excellent Wind, thou, God of the plain, thou, God of Quiac-Basulup, thou, God of Retal-Uleu, thou, lord of San Gregorio, thou, lord of Chii-Masa. [These are mountains and localities, and in the original there follow the names of more than a hundred others. The prayer concludes as follows:]

". . . . I who appoint myself godfather and godmother, I who ask, I the witness and brother of this man who asks, of this man who makes himself your son, O holy souls, I ask, do not let any evil happen unto him, nor let him be unhappy for any cause.

"I the priest, I who speak, I who burn this incense, I who light this candle, I who pray for him, I who take him under my protection, I ask you that he may obtain his subsistence with facility. Thou, God, canst provide him with money; let him not fall ill of fever; I ask that he shall

* The "holy souls" who are here appealed to by name are those of deceased *ah-kih*, or priests of the native cult.

not become paralytic; that he may not choke with severe coughing; that he be not bitten by a serpent; that he become neither bloated nor asthmatic; that he do not go mad; that he be not bitten by a dog; that he be not struck by lightning; that he be not choked with brandy; that he be not killed with iron, nor by a stick, and that he be not carried off by an eagle; guard him, O clouds; aid him, O lightning; aid him, O thunder; aid him, St. Peter; aid him, St. Paul; aid him, eternal Father.

"And I who up to this time have spoken for him to you, I ask you that sickness may visit his enemies. So order it, that when his enemies go forth from their houses, they may meet sickness; order it, that wherever they go, they may meet troubles; do your offices of injury to them, wheresoever they are met; do this that I pray, O holy souls. God be with you; God the Father, God the Son, God the Holy Spirit; Amen, Jesus."

Most of such invocations are expressed in terms far more recondite and symbolic than the above. We have many such preserved in the work of Jacinto de la Serna, which supply ample material to acquaint us with the peculiarities of the sacred and secret language of the nagualists. I shall quote but one, that employed in the curious ceremony of "calling back the *tonal*," referred to on a previous page. I append an explanation of its obscure metaphors.

*Invocation for the Restitution of the Tonal.*

"Ho there! Come to my aid, mother mine of the skirt of precious stones![1] What keeps thee away, gray ghost, white ghost?[2] Is the obstacle white, or is it yellow? See, I place here the yellow enchantment and the white enchantment.[3]

"I, the Master of the Masters of enchantments, have come, I, who formed thee and gave thee life.[4] Thou, mother mine of the starry skirt, thou, goddess of the stars, who givest life, why hast thou turned against this one?[5]

"Adverse spirit and darkened star, I shall sink thee in the breadth and depth of the waters.[6] I, master of spells, speak to thee Ho there! Mother mine, whose skirt is made of gems, come, seek with me the shining spirit who dwells in the house of light,[7] that we may know what god or mighty power thus destroys and crushes to earth this unfortunate one. Green and black spirit of sickness, leave him and seek thy prey elsewhere.

"Green and yellow ghost, who art wandering, as if lost, over mountains and plains, I seek thee, I desire thee; return to him whom thou hast abandoned. Thou, the nine times beaten, the nine times smitten, see that thou fail me not.[8] Come hither, mother mine, whose robe is of precious

gems; one water, two waters; one rabbit, two rabbits; one deer, two deers; one alligator, two alligators.[9]

"Lo! I myself am here; I am most furious; I make the loudest noise of all; I respect no one; even sticks and stones tremble before me. What god or mighty power dare face me, me, a child of gods and goddesses?[10] I have come to seek and call back the *tonal* of this sick one, wherever it is, whithersoever it has wandered, be it nine times wandered, even unto the nine junctures and the nine unions.[11] Wherever it is, I summon it to return, I order it to return, and to heal and clean this heart and this head."

### *Explanations.*

1. The appeal is to Water, regarded as the universal Mother. The "skirt of precious stones" refers to the green of the precious green stones, a color sacred to water.
2. The question is addressed to the *tonal*.
3. The yellow enchantment is tobacco; the white, a cup of water.
4. That is, assigned the form of the nagual belonging to the sick man.
5. This appeal is directed to the Milky Way.
6. The threat is addressed to the *tonal*, to frighten it into returning.
7. The "shining spirit" is the Fire-god.
8. The yellow tobacco, prepared ceremonially in the manner indicated.
9. These are names of days in the native calendar which are invoked.
10. The priest speaks in the person of his god.
11. Referring to the Nahuatl belief that there are nine upper and nine under worlds.

From the same work of de la Serna I collect the following list of symbolic expressions. It might easily be extended, but these will be sufficient to show the figurative obscurities which they threw around their formulas of conjuration, but which were by no means devoid of coherence and instruction to those who could understand them.

### *Symbolic Expressions of the Nagualists.*

*Blood.*—"The red woman with snakes on her gown" (referring to the veins).

*Copal Gum.*—"The white woman" (from the whitish color of the fresh gum).

*Cords* (for carrying burdens).—"The snake that does woman's work" (because women sit still to knit, and the cord works while itself is carried).

*Drunkenness.*—"My resting time," or "when I am getting my breath."

*The Earth.*—"The mirror that smokes" (because of the mists that rise

from it); "the rabbit with its mouth upward" (the rabbit, in opposition to the one they see in the moon; with its mouth upward, because of the mists which rise from it like the breath exhaled from the mouth); "the flower which contains everything" (as all fruit proceeds from flowers, so does all vegetable life proceed from the earth, which is therefore spoken of as a flower); "the flower which bites the mouths" (a flower, for the reason given; it eats the mouths, because all things necessarily return to it, and are swallowed by it).

*Fingers.*—"The five fates," or "the five works," or "the five fields" (because by the use of his fingers man works out his own destiny. Hence also the worship of the Hand among the Nahuas as the god Maitl, and among the Mayas as the god Kab, both which words mean "hand").

*Fire.*—"Our Father of the Four Reeds" (because the ceremony of making the new fire was held on the day Four Reeds, 4 Acatl); "the shining rose;" "the yellow flyer;" "the red-haired one;" "the yellow spirit."

*A Knife of Copper.*—"The yellow Chichimec" (because the Chichimecs were alleged to tear out the bowels of their enemies).

*The Maguey Plant.*—"My sister, the eight in a row" (because it was planted in this manner).

*A Road.*—"That which is divided in two, and yet has neither beginning, middle nor end" (because it always lies in two directions from a person, and yet all roads lead into others and thus never end).

*Sickness.*—"The red woman;" "the breath of the flame;" "our mother the comet" (all referring to the fever); "the Chichimec" (because it aims to destroy life, like these savage warriors); "the spider" (because of its venomous nature).

*Smoke.*—"The old wife" (*i. e.*, of the fire).

*The Sun.*—"Our holy and pockified Uncle" (referring to the myth of Nanahuatl, who was syphilitic, and leaping into the flames of a fire rose as the sun).

*Tobacco.*—"The nine (or seven) times beaten" (because for sacred purposes it was rubbed up this number of times); "the enchanted gray one" (from its color and use in conjuring).

*Water.*—"The Green Woman" (from the greenness which follows moisture); "our Mother, whose robe is of precious stones" (from the green or vegetable life resembling the turquoise, emerald, jade, etc.).

**36.** It might be asked how the dark arts and secret ceremonies of the Nagualists escaped the prying eyes of the officers of the Holy Inquisition, which was established in Mexico in 1571. The answer is, that the inquisitors were instructed by Cardinal Diego de Espinosa, who at that time was Inquisitor General and President of the Council of the Indies, "to abstain from proceedings against Indians, because of their stupidity and

incapacity, as well as scant instruction in the Holy Catholic faith, for the crimes of heresy, apostasy, heretical blasphemy, sorcery, incantations, superstitions," etc.

Energetic inquisitors, however, conceded very grudgingly this exemption. In the imposing *auto de fé* celebrated in the city of Mexico, in 1659, a half-breed, Bernardo del Carpio by name, son of a full-blood Indian mother, accused of blasphemy, etc., endeavored to escape the Holy Office by pleading his Indian blood; but his appeal was disallowed, and the precedent established that any admixture whatever of European blood brought the accused within the jurisdiction of the Inquisition.* Even this seems to have been a concession, for we find the record of an *auto de fé* held in 1609, in the province of Tehuantepec, in which eight full-blood natives were punished for worshiping the goddess Pinopiaa.† Mr. David Ferguson, however, who has studied extensively the records of the inquisition in Mexico, informs me that in none of the trials read by him has he observed any charges of Nagualism, although many white persons were accused, and some tried, for consulting Indian sorcerers.

**37.** It will be seen from what I have said, that the rites of Nagualism extended as widely as did the term over Mexico and Central America. It becomes, therefore, of importance to discover from what linguistic stock this term and its associated words are derived. From that source it is reasonable to suppose the rites of this superstition also had their origin.

The opinions on this subject have been diverse and positive. Most writers have assumed that it is a Nahuatl, or pure Mexican, word; while an eminent authority, Dr. Stoll, is not less certain that it is from a radical belonging to the neighboring great stock of the Mayan dialects, and especially the Quiche, of Guatemala.‡ Perhaps both these positions are erroneous, and we

* See the *Relacion del Auto celebrado en Mexico, año de* 1659 (Mexico, En la Imprenta del Santo Officio, 1659).

† J. B. Carriedo, *Estudios Historicos del Estado Oaxaqueno*, Tom. i, pp 8, 9 (Oaxaca, 1849). About 1610 a number of Indians in the province of Acapulco were put to death for having buried enchanted ashes beneath the floor of a chapel! (Serna, *Manual de Ministros*, p. 52.)

‡ "Nagual ist in seiner correcten Form *naoal* ein echtes Quiché-Wort, ein Substantivum instrumentale, vom Stamme *naó*, wissen, erkennen. *Naoal* ist dasjenige, womit oder woran etwas, in diesem Falle das Schicksal des Kindes, erkannt wird, und hat mit dem mexikanischen *nahualli* (Hexe), mit dem man es vielleicht in Verbindung bringen möchte, nichts zu schaffen." *Guatemala*, s. 238.

must look elsewhere for the true etymology of these expressions. Unquestionably they had become domesticated in both Maya and Nahuatl; but there is some reason to think they were loan-words, belonging to another, and perhaps more venerable, civilization than either of these nations could claim.

To illustrate this I shall subjoin several series of words derived from the same radical which is at the basis of the word nagual, the series, three in number, being taken from the three radically diverse, though geographically contiguous, linguistic stocks, the Maya, the Zapotec and the Nahuatl.

### *From the Maya, of Yucatan.*

*Naual*, or *nautal*, a native dance, forbidden by the missionaries.
*Naatil*, talent, skill, ability.
*Naat*, intelligence, wisdom.
*Naatah*, to understand, to divine.
*Nanaol*, to consider. to contemplate, to meditate, to commune with oneself, to enter into oneself.
*Noh*, great, skillful; as *noh ahceh*, a skillful hunter.

### *From Maya Dialects.*

#### QUICHE-CAKCHIQUEL.

*Naual*, a witch or sorcerer.
*Naualin*, to tell fortunes, to predict the future.
*Qui naualin*, to sacrifice, to offer sacrifices.
*Na*, to feel, to suspect, to divine, to think in one's heart.
*Nao*, to know, to be alert or expert in something.
*Naol*, a skillful person, a rhetorician.
*Naotizan*, to make another intelligent or astute.
*Natal*, the memory.
*Natub*, the soul or shadow of a man.
*Noh*, the god of reason ("Genius der Vernunft," Scherzer).
*Noh*, to fecundate, to impregnate (*Popol Vuh*).

#### TZENTAL.

*X-qna*, to know.
*X-qnaulai*, to know often or thoroughly (frequentative).
*Naom*, wise, astute (*naom vinic*, hombre sabio).
*Naoghi*, art, science.
*Naoghibal*, memory.
*Ghnaoghel*, a wise man.
*Alaghom naom*, the Goddess of Wisdom.

*From the Zapotec, of Oaxaca.*

*Nana, gana, gõna,* to know.
*Nona,* to know thoroughly, to retain in the memory.
*Nana ticha,* or *nona lii,* a wise man.
*Guela nana,* or *guela nona,* wisdom, knowledge.
*Hue gona,* or *ro gona,* a teacher, a master.
*Na lii,* truth ; *ni na lii,* that which is true.
*Naciña,* or *naciina,* skill, dexterity.
*Hui naa,* a medicine man, a "nagualist."
*Nahaa,* to speak pleasantly or agreeably.
*Nayaa,* or *nayapi,* to speak easily or fluently.
*Rigoo gona,* to sacrifice, to offer sacrifice.
*Ni nana,* the understanding, the intelligence, generally.
*Nayanii,* the superior reason of man.
*Nayaa,* } superiority, a superior man (gentileza, gentil hombre).
*Naguii,* }

*From the Nahuatl, of Mexico.*

*Naua,* to dance, holding each other by the hands.
*Naualli,* a sorcerer, magician, enchanter.
*Nauallotl,* magic, enchantment, witchcraft.
*Nauatl,* or *nahuatl,* skillful, astute, smart ; hence, superior ; applied to language, clear, well-sounding, whence (perhaps) the name of the tongue.
*Nauati,* to speak clearly and distinctly.
*Nauatlato,* an interpreter.

**38.** I believe that no one can carefully examine these lists of words, all taken from authorities well acquainted with the several tongues, and writing when they still retained their original purity, without acknowledging that the same radical or syllable underlies them all ; and further, that from the primitive form and rich development of this radical in the Zapotec, it looks as if we must turn to it to recognize the origin of all these expressions, both in the Nahuatl and the Maya linguistic stocks.

The root *na,* to know, is the primitive monosyllabic stem to which we trace all of them. *Nahual* means knowledge, especially mystic knowledge, the Gnosis, the knowledge of the hidden and secret things of nature; easily enough confounded in uncultivated minds with sorcery and magic.*

* The Abbé Brasseur observes : "Le mot *nahual,* qui vet dire toute science, ou science de tout, est fréquemment employé pour exprimer la sorcellerie chez ces populations." *Bulletin de la Société de Géographie,* 1857, p. 290. In another passage of his works the speculative Abbé translates *naual* by the English "know all," and is not averse to believing that the latter is but a slight variant of the former.

It is very significant that neither the radical *na* nor any of its derivatives are found in the Huasteca dialect of the Mayan tongue, which was spoken about Tampico, far removed from other members of the stock. The inference is that in the southern dialects it was a borrowed stem.

Nor in the Nahuatl language—although its very name is derived from it *—does the radical *na* appear in its simplicity and true significance. To the Nahuas, also, it must have been a loan.

It is true that de la Serna derives the Mexican *naualli*, a sorcerer, from the verb *nahualtia*, to mask or disguise oneself, "because a *naualli* is one who masks or disguises himself under the form of some lower animal, which is his *nagual*;" † but it is altogether likely that *nahualtia* derived its meaning from the custom of the medicine men to wear masks during their ceremonies.

Therefore, if the term *nagual*, and many of its associates and derivatives, were at first borrowed from the Zapotec language, a necessary corrollary of this conclusion is, that along with these terms came most of the superstitions, rites and beliefs to which they allude; which thus became grafted on the general tendency to such superstitions existing everywhere and at all times in the human mind.

Along with the names of the days and the hieroglyphs which mark them, and the complicated arithmetical methods by means of which they were employed, were carried most of the doctrines of the Nagualists, and the name by which they in time became known from central Mexico quite to Nicaragua and beyond.

The mysterious words have now, indeed, lost much of their ancient significance. In a recent dictionary of the Spanish of Mexico *nagual* is defined as "a witch; a word used to frighten children and make them behave," ‡ while in Nicaragua, where the former Nahuatl population has left so many traces of its presence in the language of to-day, the word *nagual* no longer means an actor in the black art, or a knowledge of it, but his or her

* See an article by me, entitled "On the Words 'Anahuac' and 'Nahuatl,'" in the *American Antiquarian*, for November, 1893.

† *Manual de Ministros*, p. 50.

‡ Jesus Sanchez, *Glosario de Voces Castellanas derivadas del Idioma Nahuatl*, sub voce.

armamentarium, or the box, jar or case in which are kept the professional apparatus, the talismans and charms, which constitute the stock in trade or outfit of the necromancer.*

Among the Lacandons, of Mayan stock, who inhabit the forests on the upper waters of the Usumacinta river, at the present day the term *naguate* or *nagutlat* is said to be applied to any one "who is entitled to respect and obedience by age and merit;"† but in all probability he is also believed to possess superior and occult knowledge.

**39.** All who have any acquaintance with the folk-lore of the world are aware that the notion of men and women having the power to change themselves into beasts is as wide as superstition itself and older than history. It is mentioned in the pages of Herodotus and in the myths of ancient Assyria. It is the property of African negroes, and the peasantry of Europe still hold to their faith in the reality of the were-wolf of Germany, the *loup-garou* of France and the *lupo mannaro* of Italy. Dr. Richard Andrée well says in his interesting study of the subject: "He who would explain the origin of this strange superstition must not approach it as a national or local manifestation, but as one universal in its nature; not as the property of one race or family, but of the species and its psychology at large."‡

Even in such a detail as the direct connection of the name of the person with his power of change do we find extraordinary parallelisms between the superstition of the red man of America and the peasant of Germany. As in Mexico the *nagual* was assigned to the infant by a form of baptism, so in Europe the peasants of east Prussia hold that if the godparent at the time of naming and baptism thinks of a wolf, the infant will acquire the power of becoming one; and in Hesse to pronounce the name of the person in the presence of the animal into which he has been changed will restore him to human shape.§

**40.** I need not say that the doctrine of personal spirits is not especially Mexican, nor yet American; it belongs to man in

* "*Nagual*—el lugar, rincon, cajon, nambira, etc., donde guarda sus talismanes y trajes de encanta la bruja." Berendt, *La Lengua Castellana de Nicaragua*, MS.

† Emetorio Pineda, *Descripcion Geografica de Chiapas y Soconusco*, p. 23 (Mexico, 1845).

‡ See his article "Wer-wolf," in his *Ethnographische Parallelen und Vergleiche*, p. 62, *seq.*

§ Richard Andrée, *ibid.*, ss. 63, 64.

general, and can be recognized in most religions and many philosophies. In ancient Greece both the Platonicians and later the Neo-Platonicians thought that each individual has a particular spirit, or *daimōn*, in whom is enshrined his or her moral personality. To this *daimōn* he should address his prayers, and should listen heedfully to those interior promptings which seem to arise in the mind from some unseen silent monitor.*

Many a member of the Church of Rome substitutes for the *daimōn* of the Platonists the patron saint after whom he is named, or whom he has chosen from the calendar, the hagiology, of his Church. This analogy did not fail to strike the early missionaries, and they saw in the Indian priest selecting the *nagual* of the child a hideous and diabolical caricature of the holy rites.

But what was their horror when they found that the similarity proceeded so far that the pagan priest also performed a kind of baptismal sacrament with water; and that in the Mexican picture-writing the sign which represents the natal day, the *tonal*, by which the individual demon is denoted, was none other than the sign of the cross, as we have seen. This left no doubt as to the devilish origin of the whole business, which was further supported by the wondrous thaumaturgic powers of its professors.

**41.** How are we to explain these marvelous statements? It will not do to take the short and easy road of saying they are all lies and frauds. The evidence is too abundant for us to doubt that there was skillful jugglery among the proficients in the occult arts among those nations. They could rival their colleagues in the East Indies and Europe, if not surpass them.

Moreover, is there anything incredible in the reports of the spectators? Are we not familiar with the hypnotic or mesmeric conditions in which the subject sees, hears and feels just what the master tells him to feel and see? The tricks of cutting oneself or others, of swallowing broken glass, of handling venomous reptiles, are well-known performances of the sect of the Aissaoua in northern Africa, and nowadays one does not have to go off the boulevards of Paris to see them repeated. The phenomena of thought transference, of telepathy, of clairvoy-

* See Alfred Maury, *La Magie et l'Astrologie*, pp. 88, 89, 267, etc.

*The Yolk Nucleus in Cymatogaster aggregatus Gibbons.*

*By Jesse W. Hubbard.**

(*Read before the American Philosophical Society, December 15, 1893.*)

The so called yolk nucleus is a compact, irregular mass of granules found in the yolk of the eggs of certain animals. It lies outside the germinal vesicle and usually takes a deep stain similar to the nucleolus within the germinal vesicle.

It has been seen in the eggs of Cnidarians (Häcker and others), Nematodes (Monticelli), Sagitta (Hertwig), Crustaceans (Weismann and others), Myriopods (Ludwig), Insects (Balbiani), Arachnids (Carus, Ludwig and others), Lamellibranchs (Ihering), Gastropods (Balbiani), Teleosteans (Van Bambeke), Batrachians (Cramer, Carus and others), Reptiles (Eimer), Aves (Cramer and others), Mammals (Schäfer). It is probably a normal structure of fish eggs, but on account of unfavorable conditions its complete history has not been traced in any species.

The problem we wish to solve is: (1) How does this body originate, (2) what becomes of it, (3) what function has it in the egg? There are many difficulties to the solution of the problem by ordinary fish eggs. Their great size, complexity of structure owing to accumulation of yolk, close proximity to each other and liability to crumble in sectioning—all are a detriment to its study.

Cymatogaster has in these respects many advantages over all others. (1) The eggs of this genus are the smallest of fish eggs, hence a few sections show the entire egg. The eggs of Cymatogaster reach a maximum size of .3 mm. in diameter; while other fish eggs average about 1 mm. in diameter. (2) There are comparatively few eggs in each ovary, so they are not distorted by crowding. (3) In their natural state, if uninjured by reagents, they are perfectly spherical and thus admit of easy measurement. (4) There is but little yolk when ripe and hence they may be sectioned without crumbling. (5) The nucleus seldom contains many nucleoli. It generally has but one distinct nucleolar spot. In very young eggs, and those about ripe, a few others may be seen, not more than four or five. (6) The last and most important advantage these eggs possess is the fact that the yolk nucleus is conspicuous from the time the eggs have reached a diameter of 20 $\mu$ until maturation and even beyond that to the closing of the blastopore!

The observations were made on ovaries collected by Dr. Carl Eigenmann on the coast of California. They represent individuals from 17 mm. to 140 mm. in length and were preserved chiefly in June, July and August and in October, November, December, January and February. Most of them were preserved in Flemming's strong mixture of osmic-

* Contributions from the Zoölogical Laboratory of the Indiana University, under the direction of Carl Eigenmann, iii.

chromic-acetic. A few others in platinum chloride and corrosive sublimate. Those killed in the two last mentioned were not very favorable for the study of the yolk nucleus. Some of the ovaries were stained in toto by hæmatoxylin. Others were stained on the slide by eosin. This is an excellent stain for eggs near maturity. The former was the better for younger eggs. After clearing with clove oil and infiltration in paraffin they were cut and mounted in Canada Balsam.

I made a number of experiments with different staining media. Neither mythyl green, mythyl violet, dahlia or safrinin sufficiently differentiated the tissues and the body I wished to trace. I found, however, that mythyl violet did not stain anything in the ovary, but did stain the outside muscular tissue and the spermatazoans contained in the ovary, the latter being stained a bright violet. Using alcoholic eosin and methyl violet as a double stain rendered all the tissues red except the spermatozoöns, which were a bright violet.

I have examined the ovaries of very small fish measuring 17 mm., 29 mm., 35 mm. and 40 mm. in length. In none of the largest eggs of these did I find any trace of a yolk nucleus. In a fish 45 mm. long I found a few eggs which seemed to have this body, but not at all distinct, as the ovary was not well preserved. The adult fish reaches a length 140 mm. In a fish 70 mm. long I found this body quite distinct. So it must appear in the egg when the fish is between 40 mm. and 70 mm. in length. But, as I had no specimens between these two sizes, I cannot definitely determine just when it appears in the egg.

In the young, 40 mm. and less in length, the largest eggs measure 35 $\mu$, 30 $\mu$, 25 $\mu$. In none of these eggs was the body visible in the protoplasm of the egg. But eggs about the same size as above found in an ovary of an adult fish showed clearly the presence of this body. This early stage was not seen in all the ovaries sectioned. The one in which it was seen was taken October 21, killed in osmic-chromic acetic, stained in hæmatoxylin, cleared with clove oil and mounted in Canada Balsam. The smallest egg in which the yolk nucleus was observed was 20 $\mu$ in diameter, *i. e.*, it was smaller than the largest egg in the ovary of the small fish 40 mm. in length, in which the yolk nucleus had not appeared. In these eggs of the adult fish the protoplasm around one side of the nucleus takes a deep stain. It appears as a crescent-shaped body, fitting very closely to one side of the nucleus and forming a kind of cap (Fig. 1, yk. nl.). Another egg of the same measurement shows a little more advanced stage. The body is more definite in shape, not of so pronounced a crescent form and appears to have enlarged considerably (Fig. 2, yk. nl.). The next important change is seen in a slightly larger egg, 25 $\mu$ in diameter (Fig. 3, yk. nl.). Here the body has assumed an oval form without any definite cell wall or hard outline. Although usually touching the nucleus it seems to have no further connection with it. In this egg it is quite large, measuring 10 $\mu$ in minor axis and $12\frac{1}{2}$ $\mu$ in major axis. From this time the body seems to have severed its connection with

the nucleus, and during the remainder of the egg's immaturity gradually moves away from the nucleus. From this fact and its early relation to the nucleus it seems evident that it must have originated from the nucleus. But there is another more potent proof that this is its origin. The largest eggs in the young fishes 17 mm., 29 mm., 35 mm. and 40 mm. in length measured as follows:

| | | | |
|---|---|---|---|
| Diameter of egg | 35 $\mu$. | Diameter of nucleus | 20 $\mu$. |
| " " | 30 $\mu$. | " " | $17\frac{1}{2}$ $\mu$. |
| " " | 25 $\mu$. | " " | 15 $\mu$. |

In other words, the diameter of the nucleus is more than half the diameter of the egg. It will be remembered that none of these eggs contained a yolk nucleus. The smallest eggs in the adult fish containing a yolk nucleus measured as follows:

| | | | |
|---|---|---|---|
| Diameter of egg | 20 $\mu$. | Diameter of nucleus | 10 $\mu$. |
| " " | 25 $\mu$. | " " | $12\frac{1}{2}$ $\mu$. |
| " " | 30 $\mu$. | " " | 15 $\mu$. |

That is, the nucleus has now been reduced to a diameter equal to one-half that of the egg. If this body originates from the nucleus as an extrusion of a part of its substance we should expect the nucleus to be relatively larger to the size of the egg before it appears than after its appearance. This is exactly the case in these eggs (compare nucleus in Fig. 1a and Fig. 3). It will be seen from the two sets of measurements given above that in the eggs in which this body is not visible the diameter of the nucleus is always *more than half* that of the egg, while in the eggs in which it is visible the diameter is *just half* that of the egg. This relation is true in all the measurements I made.

Take an egg with a diameter of 25 $\mu$ as a typical size of the smallest eggs in the adult fish and the largest in the small fish. To simplify operations I have taken the number of divisions of the mikrometer instead of the absolute measurement of the egg. Then the sizes of the eggs are expressed as follows:

| | | | |
|---|---|---|---|
| Diam. of egg in adult fish | ($s$) 5. | Diam. of nucleus | $2\frac{1}{2}$. |
| " " small " | ($o$) 5. | " " | 3. |

The dark body ($e$) in the protoplasm of the egg being an oblate spheroid measures 2 in conjugate axis and 2.375 in tranverse axis.

Now the solid contents of the nucleus in $o$ ought to equal the solid contents of the nucleus $s$, plus the solid contents of the dark body $e$, or $o = s + e$.

Formula for contents of a sphere is $V = \frac{1}{6} \pi D^3$.

" " " " oblate spheroid is $V = \frac{4}{3} \pi a^2 b$.

$V$ = volume.
D = diameter.
$a$ = semi-transverse axis.
$b$ = semi-conjugate axis.

Substituting values in the formula for the sphere $\surd$ of the nucleus of egg $o = 14.1372$. $\surd$ of the nucleus of egg $s = 8.18125$. $\surd$ of the dark body $e$ (or the oblate spheroid) $= 5.90704 +$. Therefore $o$ (14.1372) $=$ $s$ (8.1825) $+$ $e$ (5.9070 $+$), leaving an error of only .049, which amounts to very little when considering that each division of the mikrometer only equals .005 mm. and that the outlines of the dark body not being very definite it was difficult to get the precise measurement.

I think this clearly proves that the body originates from the nucleus. But I do not believe it is by ordinary cell division with the formation of a karyokinetic figure. It seems to be a general extrusion of substance from the nucleus.

It will be seen from an inspection of Figs. 4–12 that this body is considerably smaller in these stages than in smaller eggs (Fig. 3). Whether this is due to reagents causing a shrinkage or whether due to a condensation of substance I am unable to determine. After the egg is 40 $\mu$ in size (Fig. 5), at which time the body has reached its minimum size, it continues to constantly increase through all of the other sizes. It is nearly always irregular in shape and very seldom has a hard outline which might represent a cell wall.

Sometimes it assumes very peculiar shapes (see Figs. 7, 9, 10, 13). The most aberrant form is represented in Fig. 9, where it seems to have a long filament or tail, which is only seen by careful focusing.

Cymatogaster is viviparous. The eggs of this fish ripen during the months of December, January and February. In an ovary taken on October 21 they range in size from .02 mm. to .2 mm. The eggs of November 2 begin to show signs of ripening (Fig. 17 ($a$)). Here the nucleus is a little eccentric. The zona radiata is quite distinct and the follicle is well formed. At this stage of maturity there is a peculiar circular region shaded much more darkly than the remainder of the vitellus. This always appears on the side of the nucleus next to the yolk nucleus and opposite the point of the egg to which the nucleus seems to be moving, The yolk nucleus under consideration is quite close to the periphery of the egg.

November 30 some of the eggs become about ripe. Fig. 18 represents one which will probably be ripe in January. In this egg the follicle is much developed, the nucleus has become very eccentric and the yolk nucleus is nearly touching the periphery of the egg. Up to this time the constant tendency of this body has been to become further and further removed from the nucleus towards the periphery of the egg.

In the stages indicated by Figs. 19 and 20* the body has become slightly changed in appearance. These eggs are nearly ripe. The nucleus has reached its limit of eccentricity, and in one stage (Fig. 20) has lost its cell wall. I have merely indicated its position, which is seen in another section. The yolk is beginning to collect at the entodermic pole of the egg, *i. e.*, around the yolk nucleus.

* These and succeeding figures are based on preparations made by Dr. Eigenmann.

In the ripe egg (Fig. 21) the body in question is found surrounded by the yolk. This egg was in the act of giving off the second polar globule. The latter is not figured because seen in another section.

After the egg is matured this body assumes many curious and interesting shapes (Figs. 21–26). In Fig. 21 the yolk nucleus seems to have broken into large granules, several of them being grouped into a dark mass (yk. nl.). The whole region including the granules is somewhat shaded.

After the egg has segmented into two cells, the appearance is nearly the same as that just described, except the granules are not quite so large and prominent (Fig. 22). To this time the yolk nucleus has shown a granular structure, but as I have represented in the remaining figures it looses that structure and appears to be homogeneous.

In the stage represented in Fig. 23 this yolk nucleus has entirely changed its appearance. I did not have the sections to show the intermediate stages. At this time the egg has segmented into 32–64 cells. The yolk nucleus and its vicinity shows four different degrees of shading. The centre of what seems to be the yolk nucleus proper is of a lighter shade than the margin which is quite dark. Outside of this there is a still lighter shade than that within the body. Beyond the last is another still less distinct.

When the egg has segmented into many cells, perhaps 600 (Fig. 24), the yolk nucleus is larger and shows only one distinct shading.

Fig. 25 shows the greatest peculiarity of any. Here the blastopore is nearly closed. The body in question is somewhat pear-shaped and has a few small vacuoles scattered through it. It does not have such a distinctly granular structure, but is of a uniformly dark shade. It seems to form a kind of plug to the blastopore. The lower edge of this body is marked by a distinct outline, but the upper edge does not have such an outline. For a considerable region in its vicinity there are different degrees of shading. Also near the upper side there is a heavy shading which seems to consist of minute granules.

After the closing of the blastopore (Fig. 25) the yolk nucleus is much reduced in size, the shadings have disappeared and there is seen only a number of granules. The yolk also contains several similar granules scattered through it. Here it seems evident the yolk nucleus has reached the final stage of disintegration. It does not appear in any of the later stages of development. I think that the different appearances this body presents after segmentation of the egg begins are due to the fact that it is in the process of disintegration. The different depths of shading probably indicate the scattering of its substance through the yolk.

This body seems always to be situated at or nearer the entodermic end of the pole of the egg. Its position is constant during all its stages of growth. It may be utilized in determining whether the axis of the egg has any definite and uniform relation to the axis of the ovary. A compari-

son of the axis of eggs as determined by the [illegible]
shows that the axis of the egg has no uniform [illegible]
ovary.

### Summary.

1. This body originates from the nucleus [illegible] adult; soon after the cell becomes fully differentiated [illegible]

2. It constantly moves from the nucleus towards [illegible] of the egg which it reaches when the egg is ripe.

3. It is situated at the entodermic pole of the egg [illegible] later stages.

4. It is capable of growth condensing [illegible] and then continuing to grow to considerable size.

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6. It remains in the egg until the closing of [illegible] breaks up and disappears in the yolk.

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In the ripe egg (Fig. 21) the body in question is found surrounded by the yolk. This egg was in the act of giving off the second polar globule. The latter is not figured because seen in another section.

After the egg is matured this body assumes many curious and interesting shapes (Figs. 21–26). In Fig. 21 the yolk nucleus seems to have broken into large granules, several of them being grouped into a dark mass (yk. nl.). The whole region including the granules is somewhat shaded.

After the egg has segmented into two cells, the appearance is nearly the same as that just described, except the granules are not quite so large and prominent (Fig. 22). To this time the yolk nucleus has shown a granular structure, but as I have represented in the remaining figures it looses that structure and appears to be homogeneous.

In the stage represented in Fig. 23 this yolk nucleus has entirely changed its appearance. I did not have the sections to show the intermediate stages. At this time the egg has segmented into 32–64 cells. The yolk nucleus and its vicinity shows four different degrees of shading. The centre of what seems to be the yolk nucleus proper is of a lighter shade than the margin which is quite dark. Outside of this there is a still lighter shade than that within the body. Beyond the last is another still less distinct.

When the egg has segmented into many cells, perhaps 600 (Fig. 24), the yolk nucleus is larger and shows only one distinct shading.

Fig. 25 shows the greatest peculiarity of any. Here the blastopore is nearly closed. The body in question is somewhat pear-shaped and has a few small vacuoles scattered through it. It does not have such a distinctly granular structure, but is of a uniformly dark shade. It seems to form a kind of plug to the blastopore. The lower edge of this body is marked by a distinct outline, but the upper edge does not have such an outline. For a considerable region in its vicinity there are different degrees of shading. Also near the upper side there is a heavy shading which seems to consist of minute granules.

After the closing of the blastopore (Fig. 25) the yolk nucleus is much reduced in size, the shadings have disappeared and there is seen only a number of granules. The yolk also contains several similar granules scattered through it. Here it seems evident the yolk nucleus has reached the final stage of disintegration. It does not appear in any of the later stages of development. I think that the different appearances this body presents after segmentation of the egg begins are due to the fact that it is in the process of disintegration. The different depths of shading probably indicate the scattering of its substance through the yolk.

This body seems always to be situated at or nearer the entodermic end of the pole of the egg. Its position is constant during all its stages of growth. It may be utilized in determining whether the axis of the egg has any definite and uniform relation to the axis of the ovary. A compari-

son of the axis of eggs as determined by the position of the yolk nucleus shows that the axis of the egg has no uniform relation to the axis of the ovary.

## Summary.

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4. It is capable of growth condensing apparently when very young and then continuing to grow to considerable size.

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The majority of papers on embryology which mention this body dismiss it without much comment. However, there are a few writers who attempt to explain its function in other animals. The consensus of opinion seems to be that it is the centre of yolk formation. But there is no direct evidence that such is the case. It is mere speculation from the fact that it is found in the protoplasm of the egg, before the yolk is formed. In the eggs of Cymatogaster I have never seen any evidence that it gives rise to the yolk. The yolk globules are scattered through the protoplasm, seeming to appear equally in all parts of the egg. As the yolk gradually forms it is homogeneously distributed in different sectors of the egg until maturation. Then the yolk collects at the entodermic pole of the egg, where the yolk nucleus has become located long before.

The close association which this body has with the yolk would seem to indicate that it is in some way connected with it. But how? I think in many of the eggs in which this body has been seen it is not at all functional. But from the length of time it remains in the eggs of Cymatogaster and from the wonderful changes it undergoes in growth it would seem to be functional in this egg. Dr. Eigenmann has shown that these eggs mature very rapidly and hence have a small amount of yolk. This fact may account for the yolk nucleus remaining so long after segmentation begins. If the egg matured very slowly and allowed the formation of a large amount of yolk this body would probably disappear before the egg is ripe, as it does in other fishes.

Another interesting question arises as to what determines its position

exactly at the entodermic pole of the egg. It seems to tend to that definite position when it first leaves the nucleus. But without any question it takes up its station there before the nucleus begins to move towards the periphery of the egg, as the nucleus always moves in a directly opposite direction from the body. In all eggs the yolk collects at the entodermic pole of the egg. Does this peculiar body serve as an attraction for the yolk in this egg? Or is it a mere coincidence that it is in the midst of the yolk and has no particular connection with it?

In conclusion, I would say that I cannot definitely determine its function. I think the body is homologous with the meganucleus in protozoans. It is the vegetative portion of the egg given off from the nucleus when the egg cell has become fully differentiated as such. That which remains of the nucleus is homologous with the micronucleus in protozoans. It is the animal part of the egg which is further concerned wholly with the reproduction of the species.

## Historical Review of the Literature on the Yolk Nucleus.

Hoffman ('78, p. 545) in his studies on the young ovarian eggs of amphibians saw the yolk nucleus in *Rana esculentia*. He merely mentions it and describes it as a round, dark, granular body within the yolk. He says it is not seen in all amphibians.

Balbiani ('79) has had some very peculiar views on the origin of this body. His ideas being now so untenable, I quote this more as a curiosity than as shedding any light on the true origin. He considers the follicular cells as homologous to the spermatoblasts. The yolk nucleus corresponds to the spermatic elements. One, becoming free from the follicle, penetrates the yolk. When it first enters it leaves a sort of canal behind it, which is soon closed up by the surrounding yolk. It is a sort of spermatozoid and partially fertilizes the egg preliminary to the true fertilization which takes place later. In parthenogenetic eggs this body would perform the function of the male element. If his descriptions are based on facts the body he described is not homologous with the yolk nucleus of authors in general.

Schäfer ('80) describes and figures this body in the eggs of the rabbit. He thinks he saw some connection between the nucleus and the yolk nucleus. He believes that the latter is derived from the former, but not by a process of ordinary cell division.

Schütz ('82) has given an extended review of this body as seen in various classes of animals. But he seems to have no adequate conception either of its origin, function or fate. He remarks that the yolk may have produced it and that it later serves as nutrition for the yolk. The observations were made on isolated specimens of fresh eggs. No sections were made nor was the body traced out in any single species. He has, however, carefully compiled a large list of animals in which it has been seen, and has described its structure and appearance in many of them. His refer-

ences to the literature on the subject is extensive, but, much of it being inaccessible to me, I have made no note of what I could not personally examine.

Van Bambeke ('83) studied this body in the eggs of *Luciscus rutilus* and *Rhodeus amarus*. He says very little as to its origin, but thinks it may come from the nucleus. His figures show it to be connected with the nucleus by a funnel-shaped tube, the large end of which encloses the nucleus and the small end touches the yolk nucleus. From this appearance it would seem to be connected in some way with the nucleus. He seems to think this body is the centre of the yolk elements.

Balbiani ('83, p. 676) found this body in the eggs of *Geophiles*. In these eggs the nucleus sends out prolongations. These break off close to the nucleus and in turn they break up into large granules. These take a deep stain. These granules, he thought afterwards, left the vitellus and became the cells of the follicle. In this theory he was supported by Fol, Roule and Sabatier. There was one granule, however, that became differentiated from the others, and instead of forming a cell of the follicle remained in the vitellus and became what is known as the yolk nucleus. He thought its function was to originate the yolk. He says: "The first granulations of yolk are produced on the surface of this body and afterwards distribute themselves to all parts of the egg." In some animals he finds lines radiating in all directions from this body. Forming the limit to these radiating lines are concentric layers of substance.

Balfour ('85, pp. 21, 50) describes the yolk nucleus as seen in *Araneina* by Ludwig and others. He says it always disappears before development commences. He remarks that it is probably connected in some way with the nutrition of the ovum. This body is not found in all genera of *Araneina*.

Haeker ('92, p. 251) having studied this body in *Aequorea forskalea* calls it the metanucleolus. In the ovarian eggs it was present within the nucleus as the nucleolus. One half hour after being laid the nucleus appeared to extrude this body. He traced the body in the blastomeres until a late stage in cleavage. The author thinks homologous structures have been seen in other Medusæ. He considers the paracopulation cells of Daphnids described by Weismann and Ishikawa as homologous with the metanucleus of Medusæ. Haeker did not observe any division or any radial arrangement of protoplasm around this body.

Monticelli ('92) has studied this structure in the ova of *Distomum veliporum* and *D. richiardi*. He concludes that the vitelline nucleus is a cytoplasmic product, a nutritive differentiation probably acting as a centre in the formation of yolk.

# *The Yolk Nucleus in Cymatogaster aggregatus Gibbons.*

*By Jesse W. Hubbard.**

(*Read before the American Philosophical Society, December 15, 1893.*)

The so called yolk nucleus is a compact, irregular mass of granules found in the yolk of the eggs of certain animals. It lies outside the germinal vesicle and usually takes a deep stain similar to the nucleolus within the germinal vesicle.

It has been seen in the eggs of Cnidarians (Häcker and others), Nematodes (Monticelli), Sagitta (Hertwig), Crustaceans (Weismann and others), Myriopods (Ludwig), Insects (Balbiani), Arachnids (Carus, Ludwig and others), Lamellibranchs (Ihering), Gastropods (Balbiani), Teleosteans (Van Bambeke), Batrachians (Cramer, Carus and others), Reptiles (Eimer), Aves (Cramer and others), Mammals (Schäfer). It is probably a normal structure of fish eggs, but on account of unfavorable conditions its complete history has not been traced in any species.

The problem we wish to solve is: (1) How does this body originate, (2) what becomes of it, (3) what function has it in the egg? There are many difficulties to the solution of the problem by ordinary fish eggs. Their great size, complexity of structure owing to accumulation of yolk, close proximity to each other and liability to crumble in sectioning—all are a detriment to its study.

Cymatogaster has in these respects many advantages over all others. (1) The eggs of this genus are the smallest of fish eggs, hence a few sections show the entire egg. The eggs of Cymatogaster reach a maximum size of .3 mm. in diameter; while other fish eggs average about 1 mm. in diameter. (2) There are comparatively few eggs in each ovary, so they are not distorted by crowding. (3) In their natural state, if uninjured by reagents, they are perfectly spherical and thus admit of easy measurement. (4) There is but little yolk when ripe and hence they may be sectioned without crumbling. (5) The nucleus seldom contains many nucleoli. It generally has but one distinct nucleolar spot. In very young eggs, and those about ripe, a few others may be seen, not more than four or five. (6) The last and most important advantage these eggs possess is the fact that the yolk nucleus is conspicuous from the time the eggs have reached a diameter of 20 $\mu$ until maturation and even beyond that to the closing of the blastopore!

The observations were made on ovaries collected by Dr. Carl Eigenmann on the coast of California. They represent individuals from 17 mm. to 140 mm. in length and were preserved chiefly in June, July and August and in October, November, December, January and February. Most of them were preserved in Flemming's strong mixture of osmic-

* Contributions from the Zoölogical Laboratory of the Indiana University, under the direction of Carl Eigenmann, iii.

chromic-acetic. A few others in platinum chloride and corrosive sublimate. Those killed in the two last mentioned were not very favorable for the study of the yolk nucleus. Some of the ovaries were stained in toto by hæmatoxylin. Others were stained on the slide by eosin. This is an excellent stain for eggs near maturity. The former was the better for younger eggs. After clearing with clove oil and infiltration in paraffin they were cut and mounted in Canada Balsam.

I made a number of experiments with different staining media. Neither mythyl green, mythyl violet, dahlia or safrinin sufficiently differentiated the tissues and the body I wished to trace. I found, however, that mythyl violet did not stain anything in the ovary, but did stain the outside muscular tissue and the spermatazoans contained in the ovary, the latter being stained a bright violet. Using alcoholic eosin and methyl violet as a double stain rendered all the tissues red except the spermatozoöns, which were a bright violet.

I have examined the ovaries of very small fish measuring 17 mm., 29 mm., 35 mm. and 40 mm. in length. In none of the largest eggs of these did I find any trace of a yolk nucleus. In a fish 45 mm. long I found a few eggs which seemed to have this body, but not at all distinct, as the ovary was not well preserved. The adult fish reaches a length 140 mm. In a fish 70 mm. long I found this body quite distinct. So it must appear in the egg when the fish is between 40 mm. and 70 mm. in length. But, as I had no specimens between these two sizes, I cannot definitely determine just when it appears in the egg.

In the young, 40 mm. and less in length, the largest eggs measure 35 $\mu$, 30 $\mu$, 25 $\mu$. In none of these eggs was the body visible in the protoplasm of the egg. But eggs about the same size as above found in an ovary of an adult fish showed clearly the presence of this body. This early stage was not seen in all the ovaries sectioned. The one in which it was seen was taken October 21, killed in osmic-chromic acetic, stained in hæmatoxylin, cleared with clove oil and mounted in Canada Balsam. The smallest egg in which the yolk nucleus was observed was 20 $\mu$ in diameter, *i. e.*, it was smaller than the largest egg in the ovary of the small fish 40 mm. in length, in which the yolk nucleus had not appeared. In these eggs of the adult fish the protoplasm around one side of the nucleus takes a deep stain. It appears as a crescent-shaped body, fitting very closely to one side of the nucleus and forming a kind of cap (Fig. 1, yk. nl.). Another egg of the same measurement shows a little more advanced stage. The body is more definite in shape, not of so pronounced a crescent form and appears to have enlarged considerably (Fig. 2, yk. nl.). The next important change is seen in a slightly larger egg, 25 $\mu$ in diameter (Fig. 3, yk. nl.). Here the body has assumed an oval form without any definite cell wall or hard outline. Although usually touching the nucleus it seems to have no further connection with it. In this egg it is quite large, measuring 10 $\mu$ in minor axis and $12\frac{1}{2}$ $\mu$ in major axis. From this time the body seems to have severed its connection with

the nucleus, and during the remainder of the egg's immaturity gradually moves away from the nucleus. From this fact and its early relation to the nucleus it seems evident that it must have originated from the nucleus. But there is another more potent proof that this is its origin. The largest eggs in the young fishes 17 mm., 29 mm., 35 mm. and 40 mm. in length measured as follows:

| | | | | | |
|---|---|---|---|---|---|
| Diameter of egg | ............ | 35 $\mu$. | Diameter of nucleus | ........ | 20 $\mu$. |
| " " | ............ | 30 $\mu$. | " " | ........ | $17\frac{1}{2}$ $\mu$. |
| " " | ............ | 25 $\mu$. | " " | ........ | 15 $\mu$. |

In other words, the diameter of the nucleus is more than half the diameter of the egg. It will be remembered that none of these eggs contained a yolk nucleus. The smallest eggs in the adult fish containing a yolk nucleus measured as follows:

| | | | | | |
|---|---|---|---|---|---|
| Diameter of egg | ............ | 20 $\mu$. | Diameter of nucleus | ........ | 10 $\mu$. |
| " " | ............ | 25 $\mu$. | " " | ........ | $12\frac{1}{2}$ $\mu$. |
| " " | ............ | 30 $\mu$. | " " | ........ | 15 $\mu$. |

That is, the nucleus has now been reduced to a diameter equal to one-half that of the egg. If this body originates from the nucleus as an extrusion of a part of its substance we should expect the nucleus to be relatively larger to the size of the egg before it appears than after its appearance. This is exactly the case in these eggs (compare nucleus in Fig. 1a and Fig. 3). It will be seen from the two sets of measurements given above that in the eggs in which this body is not visible the diameter of the nucleus is always *more than half* that of the egg, while in the eggs in which it is visible the diameter is *just half* that of the egg. This relation is true in all the measurements I made.

Take an egg with a diameter of 25 $\mu$ as a typical size of the smallest eggs in the adult fish and the largest in the small fish. To simplify operations I have taken the number of divisions of the mikrometer instead of the absolute measurement of the egg. Then the sizes of the eggs are expressed as follows:

| | | | | |
|---|---|---|---|---|
| Diam. of egg in adult fish | .....($s$) 5. | Diam. of nucleus | ............ | $2\frac{1}{2}$. |
| " " small " | ....($o$) 5. | " " | ............ | 3. |

The dark body ($e$) in the protoplasm of the egg being an oblate spheroid measures 2 in conjugate axis and 2.375 in tranverse axis.

Now the solid contents of the nucleus in $o$ ought to equal the solid contents of the nucleus $s$, plus the solid contents of the dark body $e$, or $o = s + e$.

Formula for contents of a sphere is $V = \frac{1}{6} \pi D^3$.
" " " " oblate spheroid is $V = \frac{4}{3} \pi a^2 b$.

$V$ = volume.
D = diameter.
$a$ = semi-transverse axis.
$b$ = semi-conjugate axis.

Substituting values in the formula for the sphere $\vee$ of the nucleus of egg $o = 14.1372$. $\vee$ of the nucleus of egg $s = 8.18125$. $\vee$ of the dark body $e$ (or the oblate spheroid) $= 5.90704 +$. Therefore $o$ $(14.1372) =$ $s$ $(8.1825) + e$ $(5.9070 +)$, leaving an error of only .049, which amounts to very little when considering that each division of the mikrometer only equals .005 mm. and that the outlines of the dark body not being very definite it was difficult to get the precise measurement.

I think this clearly proves that the body originates from the nucleus. But I do not believe it is by ordinary cell division with the formation of a karyokinetic figure. It seems to be a general extrusion of substance from the nucleus.

It will be seen from an inspection of Figs. 4–12 that this body is considerably smaller in these stages than in smaller eggs (Fig. 3). Whether this is due to reagents causing a shrinkage or whether due to a condensation of substance I am unable to determine. After the egg is 40 $\mu$ in size (Fig. 5), at which time the body has reached its minimum size, it continues to constantly increase through all of the other sizes. It is nearly always irregular in shape and very seldom has a hard outline which might represent a cell wall.

Sometimes it assumes very peculiar shapes (see Figs. 7, 9, 10, 13). The most aberrant form is represented in Fig. 9, where it seems to have a long filament or tail, which is only seen by careful focusing.

Cymatogaster is viviparous. The eggs of this fish ripen during the months of December, January and February. In an ovary taken on October 21 they range in size from .02 mm. to .2 mm. The eggs of November 2 begin to show signs of ripening (Fig. 17 (*a*)). Here the nucleus is a little eccentric. The zona radiata is quite distinct and the follicle is well formed. At this stage of maturity there is a peculiar circular region shaded much more darkly than the remainder of the vitellus. This always appears on the side of the nucleus next to the yolk nucleus and opposite the point of the egg to which the nucleus seems to be moving, The yolk nucleus under consideration is quite close to the periphery of the egg.

November 30 some of the eggs become about ripe. Fig. 18 represents one which will probably be ripe in January. In this egg the follicle is much developed, the nucleus has become very eccentric and the yolk nucleus is nearly touching the periphery of the egg. Up to this time the constant tendency of this body has been to become further and further removed from the nucleus towards the periphery of the egg.

In the stages indicated by Figs. 19 and 20* the body has become slightly changed in appearance. These eggs are nearly ripe. The nucleus has reached its limit of eccentricity, and in one stage (Fig. 20) has lost its cell wall. I have merely indicated its position, which is seen in another section. The yolk is beginning to collect at the entodermic pole of the egg, *i. e.*, around the yolk nucleus.

* These and succeeding figures are based on preparations made by Dr. Eigenmann.

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Schütz ('82) has given an extended review of this body as seen in various classes of animals. But he seems to have no adequate conception either of its origin, function or fate. He remarks that the yolk may have produced it and that it later serves as nutrition for the yolk. The observations were made on isolated specimens of fresh eggs. No sections were made nor was the body traced out in any single species. He has, however, carefully compiled a large list of animals in which it has been seen, and has described its structure and appearance in many of them. His refer-

ences to the literature on the subject is extensive, but, much of it being inaccessible to me, I have made no note of what I could not personally examine.

Van Bambeke ('83) studied this body in the eggs of *Luciscus rutilus* and *Rhodeus amarus*. He says very little as to its origin, but thinks it may come from the nucleus. His figures show it to be connected with the nucleus by a funnel-shaped tube, the large end of which encloses the nucleus and the small end touches the yolk nucleus. From this appearance it would seem to be connected in some way with the nucleus. He seems to think this body is the centre of the yolk elements.

Balbiani ('83, p. 676) found this body in the eggs of *Geophiles*. In these eggs the nucleus sends out prolongations. These break off close to the nucleus and in turn they break up into large granules. These take a deep stain. These granules, he thought afterwards, left the vitellus and became the cells of the follicle. In this theory he was supported by Fol, Roule and Sabatier. There was one granule, however, that became differentiated from the others, and instead of forming a cell of the follicle remained in the vitellus and became what is known as the yolk nucleus. He thought its function was to originate the yolk. He says: "The first granulations of yolk are produced on the surface of this body and afterwards distribute themselves to all parts of the egg." In some animals he finds lines radiating in all directions from this body. Forming the limit to these radiating lines are concentric layers of substance.

Balfour ('85, pp. 21, 50) describes the yolk nucleus as seen in *Araneina* by Ludwig and others. He says it always disappears before development commences. He remarks that it is probably connected in some way with the nutrition of the ovum. This body is not found in all genera of *Araneina*.

Haeker ('92, p. 251) having studied this body in *Aequorea forskalea* calls it the metanucleolus. In the ovarian eggs it was present within the nucleus as the nucleolus. One half hour after being laid the nucleus appeared to extrude this body. He traced the body in the blastomeres until a late stage in cleavage. The author thinks homologous structures have been seen in other Medusæ. He considers the paracopulation cells of Daphnids described by Weismann and Ishikawa as homologous with the metanucleus of Medusæ. Haeker did not observe any division or any radial arrangement of protoplasm around this body.

Monticelli ('92) has studied this structure in the ova of *Distomum veliporum* and *D. richiardi*. He concludes that the vitelline nucleus is a cytoplasmic product, a nutritive differentiation probably acting as a centre in the formation of yolk.

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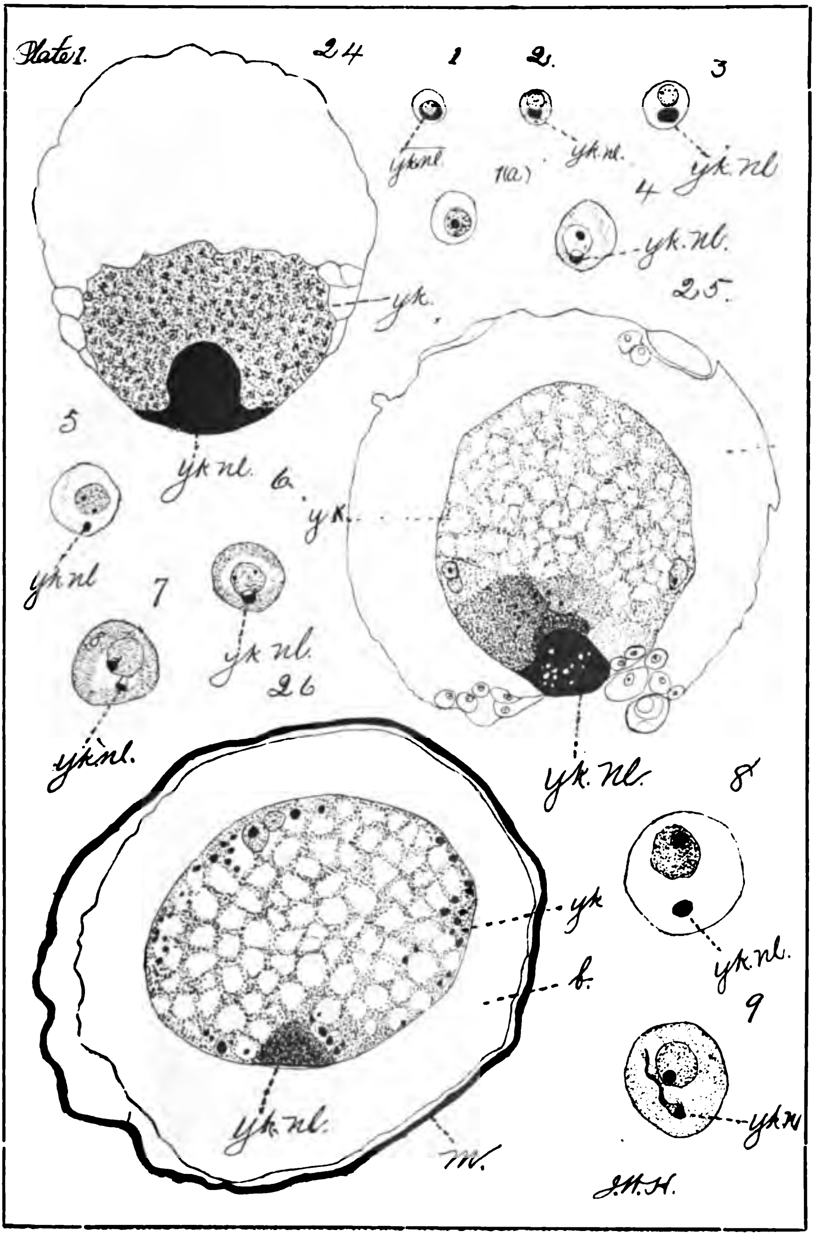
Plate 1.
24
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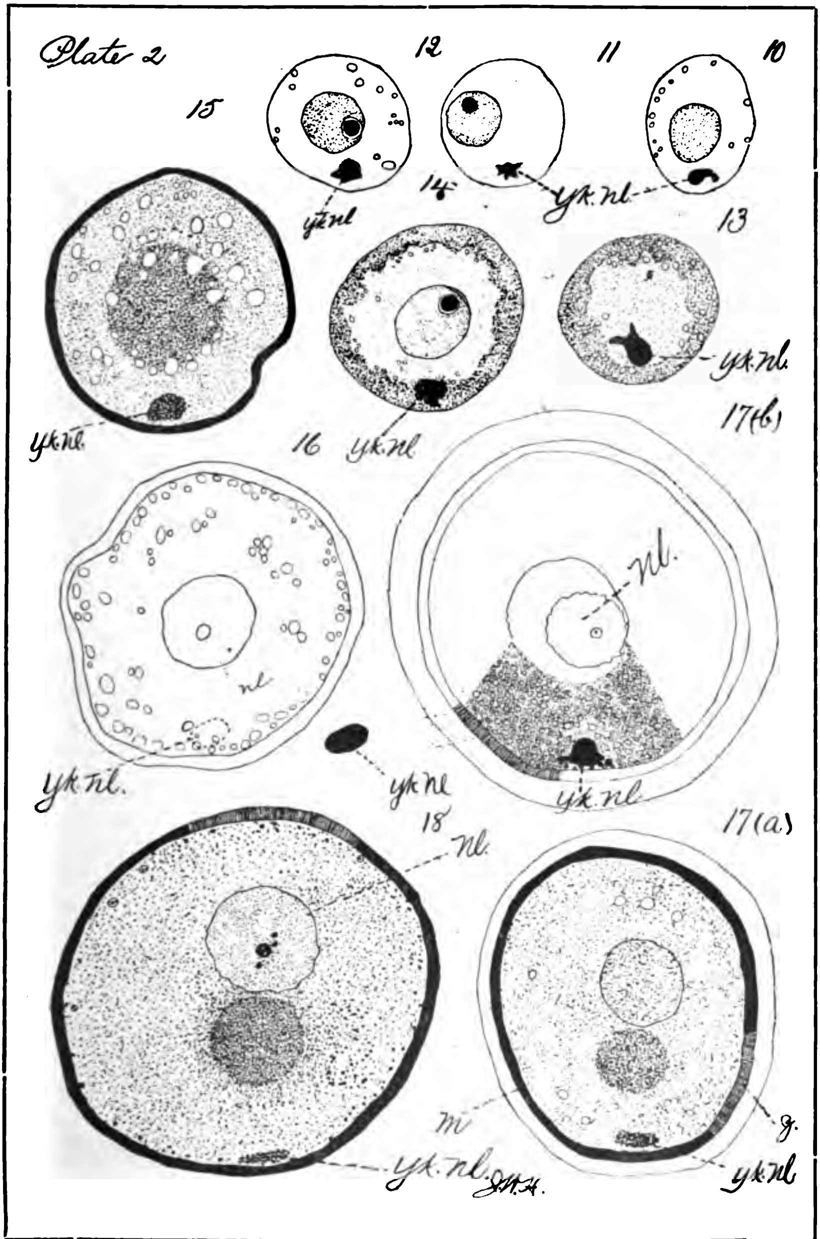
Plate 2
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17(b)
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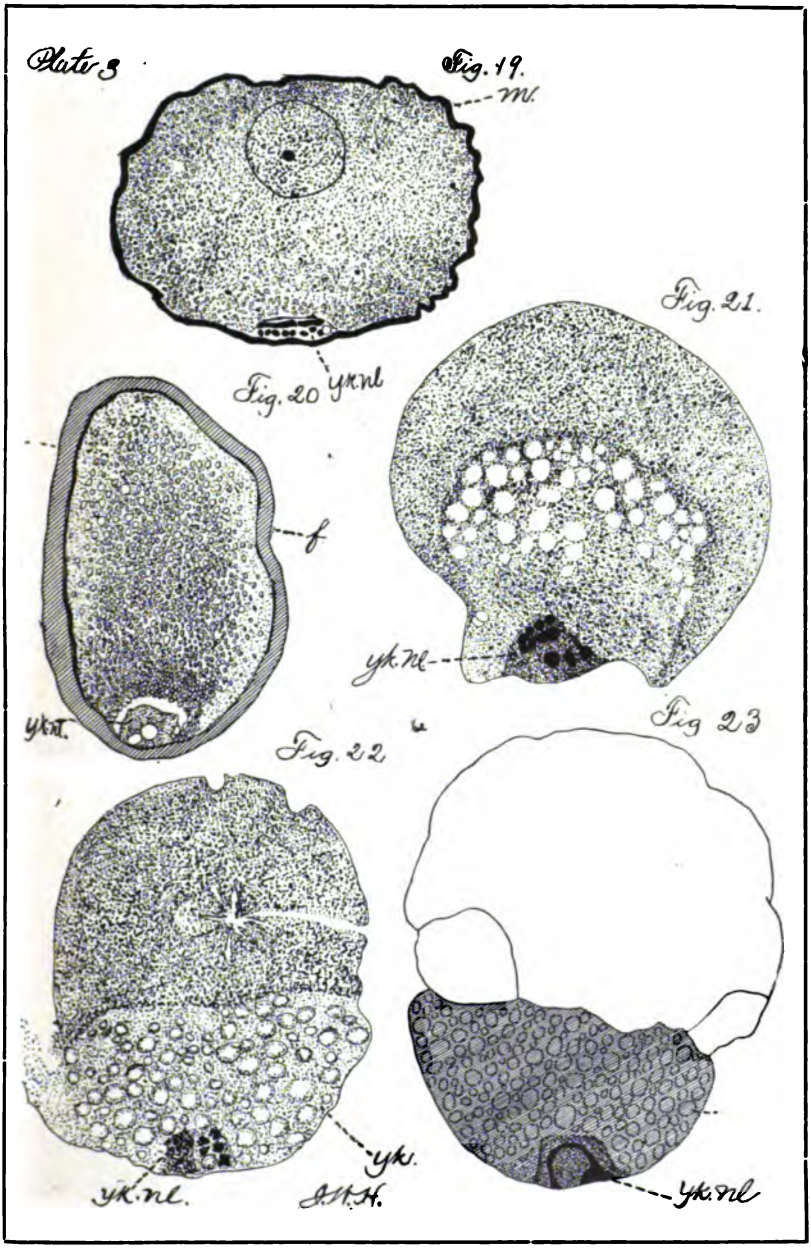
Plate 3
Fig. 19.
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Fig. 20
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Fig. 21.
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Fig 23
Fig. 22
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yk.nl.
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yk.nl

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## Explanation of Figures.

### *Abbreviations.*

*b*—blastoderm.
*f*—follicle.
*m*—egg membrane = zona radiata.
*nl*—nucleus.
*yk*—yolk.
*s*—zona radiata.
*yk. nl.*—yolk nucleus.

All the figures were drawn with the Abbe camera and Zeiss D and 4 $\mu$, x 320.

Figs. 1–9 and 24–26, inclusive, are found on Plate i.
" 10–18, inclusive, are found on Plate ii.
" 19–23, " " " " iii.

Fig. 1. First appearance of yolk nucleus in smallest eggs.
" 1(*a*). Nucleus before extrusion of yolk nucleus.
" 2, 3. Successive stages of growth.
" 4. Yolk nucleus much reduced in size.
" 5–16. Successive changes in appearance and growth of the yolk nucleus.
(All of the above eggs stained in hæmatoxylin.)
" 17(*a*), 18. Stained in eosin.
" 19. Egg near the time of maturation.
Fig. 20. A little latter stage than that of Fig. 19.
" 21. A ripe egg. Yolk collected at entodermic pole of the egg.
" 22. Egg segmented into 2 cells.
" 23. " " " 32–64 cells.
" 24. " " " many cells, probably 600.
" 25. Late stage in segmentation. Blastopore nearly closed.
" 26. Blastopore closed. Yolk nucleus somewhat scattered through the yolk.

## *On the Fishes obtained by the Naturalist Expedition in Rio Grande do Sul.*

*By E. D. Cope.*

*(Read before the American Philosophical Society, January 5, 1894.)*

The fishes of the Brazilian province of Rio Grande do Sul have been locally studied by Hensel (1868–70) and Von Jhring (1893), so that they are better known than those of some other parts of South America. The latest enumeration, that of Von Jhring, includes forty-nine species. The present report includes forty-one species, of which twenty are not found in Von Jhring's list. Perhaps three of these are enumerated by that author under different names, so that this paper adds perhaps seventeen species, bringing the whole number to sixty-six species. The number of species in Von Jhring's list which I have not found in this collection is thirty. This wide diversity in the collections is probably due to the fact that those studied by Hensel and Von Jhring were made much nearer the coast, while my collection was obtained in the interior near the mountains. The absence of various species of the lower and tide waters from my collection, together with the presence of species of the smaller streams, may be thus accounted for. A summary of the results will be given at the end of the paper.

The collection now reported on was made by Mr. H. H. Smith, who was sent to Brazil in the interest of the *American Naturalist*. A report on the Mammals was made in that periodical in the year 1889; and reports on the Reptiles and Batrachia have been published in the *Proceedings* of this Society for 1884 and 1887.

### PLECTOSPONDYLI.

#### CHARACINIDÆ.

MACRODON TAREIRA Bl. and Schn.

Authors who think, with the American Ornithologists' Union, that scientific nomenclature may record error instead of truth, call this well-known South American species, *Macrodon malabaricus*, because Bloch described it first under that name, under the mistaken idea that it was a native of India.

XIPHORHAMPHUS BRACHYCEPHALUS sp. nov.

Teeth of the maxillary bone small, equal. Head short, body deep, scales large. Depth of body entering length without caudal fin, three times; length of head in the same four times. Scales $\begin{smallmatrix}10\\51\\6\end{smallmatrix}$. Fin radii, D. 11; A. 27. Muzzle short, entering length of head 3.5 times; diameter of eye entering the same four times; interorbital space convex, its width entering length of head 3.5 times, hence equal length of muzzle. The profile is slightly descending and nearly straight. The

extremity of the maxillary bone is in line with the posterior border of the orbit. The pectoral fin reaches the base of the ventral, but the ventral does not quite reach the anal.

The color is silver, with greenish and bluish reflections. A large black spot at the base of the caudal, and a smaller one behind the epiclavicle. No lateral band.

Total length, 177 mm.; length to base of caudal fin, 145 mm.; length to base of anal, 89 mm.; length to base of ventral, 63 mm.; length of head, 37 mm.

This species is near the *X. hepsetus* Cuv. From the full description and figures given by Steindachner,* we learn that in that species, both the body and head are of more slender proportions at all ages, and that the interorbital diameter is relatively narrower. It possesses also a silver lateral band which terminates in a black stripe on the caudal peduncle and fin. The scale and ray formulæ are the same in the two species.

The *X. jenynsii* Gthr. was thought by Steindachner to be identical with the *X. hepsetus*, but he subsequently concluded that it is distinct (see *Sitzber. Wien Akad.*, 1891, p. 371). It is evidently very near the latter, and has a more slender form of head and body than the *X. brachycephalus*. The depth enters the length, according to Steindachner, 3.3 to 3.5 times; and the length of head enters the length 3.5 to 3.6 times. The interorbital width is less, entering the length of the head 4 to 4.5 times. Scales of lateral line 56–62.

Two specimens.

XIPHORHAMPHUS HEPSETUS Cuv. Steind., *l. c.*

Two specimens. The smaller measuring 179 mm., agrees with Steindachner's description, but the larger, 215 mm., differs in exceeding the proportions given as characteristic of old individuals. Thus the scale formula is $\begin{array}{c}17\\ \hline 76\\ \hline 8\end{array}$; the highest figures given by Steindachner being $\begin{array}{c}14\\ \hline 70\\ \hline 7\end{array}$. The eye enters the total length of the head 5.5 times; the highest relative proportions of Steindachner's description being 4.66 times. In both specimens the length of the head exceeds the depth of the body.

ASIPHONICHTHYS STENOPTERUS Cope, *Amer. Naturalist*, 1894, p. 67.

*Char. gen.*—Subfamily Hydrocyoninæ. Teeth on premaxillary, maxillary and dentary bones; the first in two series, the last in one; those of both of unequal lengths. Dorsal fin short, above the anterior rays of the long anal. No lateral line of pores, except on a few anterior scales. Gill-rakers lanceolate.

This genus is Anacyrtus without a lateral line of pores.

*Char. specif.*—Dorsal outline elevated; profile of cranium concave; mouth directed obliquely upwards. Scales 42, 20. Fin radii, D. 11; A. 46, the anterior three shorter; V. 9; P. 15. Depth of body 2.66 times in

* *Sitzungsber. K. Wien Akad. Wiss.*, Nov., 1876, p. 35.

length without caudal fin. Length of head 3.8 times in the same. Eye three times in head; exceeding length of muzzle and equal interorbital width. Dorsal fin elevated, narrow; pectorals narrow, covering basal third of ventrals; ventrals lanciform, reaching fourth anal ray. Color silvery, with an ill-defined silver lateral band. An obscure postclavicular dark spot, and some obscure dark dots on the silver lateral band. No basal caudal spot.

Length to end of middle caudle radii, 80 mm.; length to base of caudal fin, 72 mm.; length to base of anal (oblique) 35 mm.; length to base of ventrals, 26 mm.; length of head, 20 mm.

A single specimen from the Jacuhy. Besides the generic characters, the scales are larger than in the known species of Anacyrtus.

CHORIMYCTERUS TENUIS Cope, *Amer. Naturalist*, 1894, p. 67.

*Char. gen*—Denticulate teeth on intermaxillary and dentary bones, and in a single row on the former. On the dentary bone a second interior series of simple teeth. Dorsal and anal fins short; the former commencing in front of the base of the latter. Nares separated by a wide space. Lateral line complete.

This genus is near to Characidium, but differs in having two series of mandibular teeth. From Piabucina it differs in the separated nostrils and the presence of a lateral line.

*Char. specif.*—Form slender; the depth contained seven times in the length less the caudal fin. Profile of muzzle decurved; mouth small, the end of the maxillary nearly reaching the anterior margin of the orbit. Eye large, oval, contained in the length of the head three times, and as wide as the interorbital space opposite its posterior border. Teeth of both jaws rather elongate, with a single lateral denticle on each side of and near the acute apex. Length of head five times in total length without caudal fin. Scale $\frac{3}{\overline{39}}\over{2}$. Fin radii, D. 11; A. 9; V. 9; P. 12. Pectorals elongate, not reaching ventrals; ventrals reaching about half-way to anal. Caudal fin deeply emarginate. Color silvery, most brightly on the suborbital and opercular regions. Scales with slightly shaded borders.

Total length, 66 mm.; length to base of caudal fin, 55 mm.: length to base of anal, 41 mm.; length to base of ventral, 27 mm.; length to base of dorsal, 22 mm.; length of head, 11 mm.

This fish is more slender than the *Characidium fasciatum* of Reinhardt, and has a different scale formula and coloration. It is still more slender than the *C. etheostoma* Cope, and *C. steindachnerii* Cope.

PSEUDOCORYNOPOMA DORIÆ. Perugia, *Ann. Mus. Genoa*, x, 1891, 646.
*Bergia altipinnis* Steind., *Stzber. K. Akad. Wien*, 1891, 836.

*Char. gen.*—Dorsal fin originating above the anterior part of the elongate anal fin. Denticulate teeth on the premaxillary and dentary bones,

in two series on the former and one series on the latter; no canines. Nares close together. Pectoral and ventral regions compressed acute. Lateral line straight, continuous. Ventral fins small. Gill rakers lanceolate.

This genus is allied to Gasteropelecus, but the lateral line is of the normal type, that is, straight and continuous. From Piabucina, it differs in having two series of premaxillary teeth, and from Chalcinus in the absence of conical teeth between the dentary series. It is an interesting form connecting Gasteropelecus with Chalcinus.

*Char. specif.*—General form rhombic, the profile straight from the base of the dorsal fin to the extremity of the muzzle. Mouth opening obliquely upwards. Pectoroventral outline moderately and not extremely convex. Pectoral fin elongate, falcate, reaching anal; ventral not reaching anal. Scales $\frac{7}{\frac{40}{6}}$ Fin radii, D. 1.10; A. 37; V. 7; P. 13. Anterior rays of dorsal and anal fins in probably male individuals, produced, the former reaching the base of the caudal. The caudal deeply emarginate. Depth entering length 2.6 times; length of head entering same four times. Diameter of eye entering length of head (without chin) three times; and entering the interorbital width 1.25 times. General color silvery; a whiter silver band extending from near the epiclavicular region to the base of the caudal fin above the lateral line. No dark markings.

Total length, 67 mm.; length to base of caudal fin, 52 mm; length to base of anal (oblique), 36 mm.; length to base of dorsal (oblique), 32 mm.; length to base of ventral, 25 mm.; length to base of pectoral, 15 mm.; length of head, 13.5 mm.

This is apparently an abundant species in the Jacuhy. My specimens agree with those described by Steindachner from Montevideo, except that in the latter the eye is a little smaller, entering the length of the ead $3\frac{1}{2}$ times, and there are 40–1 anal rays. The *P. argentinum* Holmb. from the Plata (*Revista Argentina*, 1891, p. 190) is, to judge from the description, a more slender fish, with the lateral line nearer the dorsal border.

TETRAGONOPTERUS RUTILUS Jenyns; Steindachner, *Sitzungsber. Wien Akad. Wiss.*, November, 1876, p. 17.

The five species of Tetragonopterus represented in the collection may be distinguished synoptically as follows:

*a.* No teeth on the maxillary bone.

Scales of lateral line, 40; anal rays, 28; eyes, $\frac{1}{3}$ head, equal interorbital space; elongate .......................................... *T. rutilus.*

Scales of l.l., 36; anal rays, 28; eye, $\frac{1}{4}$ head, $1\frac{1}{2}$ interorbital space; orbicular.......................................... *T. jacuhiensis.*

Lateral line, 32-3; anal rays, 23; eye, 2.5, equal interorbital space; rhombic.......................................... *T. eigenmanniorum.*

Lateral line, 37 ; anal rays, 20 ; head thick ; eye, $3\frac{1}{3}$, $1\frac{1}{3}$ in interorbital ; elongate.......................................... *T. laticeps.*

*aa.* Teeth on the base of the maxillary bone.

Lateral line, 35 ; anal rays, 19 ; eye large. $2\frac{1}{3}$ in head, equal interorbital ; elongate ; no spots...................................... *T. pliodus.*

In the *T. rutilus* the form is rather elongate, the depth entering the length (minus caudal fin), 2.66 times, while the head is short, entering the length 4.5 times. The eye is large, entering the length of the head three times, and equaling the width of the convex interorbital space. The maxillary is toothless and reaches the vertical line of the anterior border of the orbit. The muzzle is as long as three-quarters the diameter of the eye. Scale formula, $\frac{7}{\frac{40}{5\frac{1}{2}}}$. Radii, D. 11 ; A. 28 ; V. 7, with a lanceolate scale at axilla. The pectoral reaches the base of the ventral, but the ventral does not reach the anal. Origin of dorsal a little posterior to that of ventral. The color is yellow silvery, whiter on the middle of the sides. Humeral and caudal spots obscure, the former not visible in some specimens ; apparently vertical where obscurely visible. Median caudal rays black.

Total length, 135 mm.; length to base of caudal, 110 mm.; length to base of anal, 70 mm.; length to base of ventral (oblique), 50 mm.; length of head, 24 mm.

The specimens agree in the main with Steindachner's description,* although the number of scales of the lateral line is a little greater than is given by him. In outline of body our specimens are most like his elongated variety (Pl. ii, Fig. 3) ; but the head is shorter, since in the variety the head enters the length four times instead of 4.5 times.

A few specimens.

TETRAGONOPTERUS JACUHIENSIS sp. nov.

The deepest bodied species of the Jacuhy, rather deeper than the *T. maculatus* of Cuvier. The depth enters the length less the caudal fin 2.25 times, and the length of the head enters the same four times. The eye is rather small, entering the length of the head four times, while the interorbital space is 1.5 times its diameter. The profile of the head is slightly concave ; and those of the back and belly are about equally convex. Scales $\frac{6\text{–}8}{\frac{36}{6\frac{1}{2}}}$. Radii, D. 11 ; A. 27–8 ; V. 8, with axillary scale. First dorsal ray a little posterior to first ventral ray. Color silvery with steel-blue reflections. Humeral and basal caudal spots conspicuous, the former subround and situated in the centre of a pale area, which is bounded posteriorly by a vertical curved black border, sometimes indistinct. Caudal spot continued on middle caudal rays.

Total length, 114 mm. ; length to base of caudal fin, 95 mm. ; length

* *Sitzungsber. K. Wien Akad.*, November, 1876, p. 17.

to base of anal, 63 mm.; length to base of ventral (oblique), on 45 mm.; length of head, 23 mm.

This species is allied to the *T. maculatus* Linn., but that species has a larger eye (one-third head) and a longer anal fin (32–3 rays). *

The number of rays is so constant in numerous specimens, that, if Steindachner's figures are correct, which there is no reason to doubt, this form must be distinct. The *T. maculatus* is ascribed by both Boulenger and Von Jhring to Rio Grande do Sul.

The proximal part of the maxillary bone is minutely serrate, but not dentate.

Fifteen specimens.

TETRAGONOPTERUS EIGENMANNIORUM sp. nov.

A species of rhombic form, differing from those above described in the smaller number of anal radii, and fewer scales of the lateral line. Depth entering length without caudal fin two and a half times; length of head in the same 3.4 times. Eye large, longer than muzzle, entering head three times, and equal interorbital width. Scales $\frac{7}{\frac{32}{6}}$. Radii, D. 11; A. 23. Ventral commencing a little anterior to first dorsal ray, not reaching anal. Pectoral reaching ventral. Profile of head very slightly concave. Dorsal and ventral profiles subsequently arched. Color silvery, with a whiter silvery lateral band. No humeral nor distinct caudal spot. Middle caudal rays dusky.

Total length, 67 mm.; length to base of caudal fin, 53 mm.; length to base of anal, 35 mm.; length to base of ventral (oblique), 26 mm.; length of head, 15 mm.

But one specimen presents exactly the typical characters of this species, but five others probably belong to it. They have a few more scales of the lateral line, as 33–4, and one has 36. They have a basal caudal spot, and four of them show traces of the humeral spot, and have a steel-blue reflection, as in the *T. jacuhiensis*. The small number of the anal rays, 23–4, distinguishes it from the latter, where there are always 27–8; and the form is more elongate.

This species is dedicated to Prof. and Mrs. C. H. Eigenmann of the University of Indiana, whose work on the fishes of South America has so elucidated the subject.

TETRAGONOPTERUS LATICEPS sp. nov.

Form, elongate oval; depth entering length (without caudal fin) 2.6 times; length of head into same, 3.75–4 times. Profile of back descending regularly from dorsal fin; of front, straight or slightly concave. Diameter of eye greater than length of muzzle, entering 3 to 3.3 times in length of head. Front slightly convex transversely, wider than diame-

* Teste Steindachner, *l. c.*, p. 10.

ter of eye, and entering length of head 2.33 to 2.5 times. Scales, $\frac{6}{37}{4\frac{1}{2}}$; Radii, D. 11; A. 20. Pectoral fin reaching base of ventral; ventral not reaching anal. No denticulations on maxillary bone. Color, silvery; a silver lateral stripe, with humeral and caudal spots. The humeral spot is subround and the caudal extends to the end of the median caudal rays.

Total length, 74 mm.; length to base of caudal fin, 60 mm.; length to first anal ray, 40 mm.; length to base of ventral (oblique), 28 mm.; length of head, 16 mm.

Eighteen specimens of this species are before me. It is allied to the *T. fasciatus* Cuv., *T. brevimanus* Gunther, and *T. jenynsii* Steindachner. The body is deeper than in the first named, and the frontal region is wider; the muzzle is shorter and the maxillary bone is not denticulate. From *T. brevimanus* it differs in the deeper body, larger eye, and longer pectoral fin. The *T. jenynsii* has a narrower front, only 33 scales of the lateral line, and the humeral spot a vertical bar. According to Steindachner's figure, the dorsal outline descends towards the dorsal fin; in *T. laticeps* it rises to that fin I would have suspected that this species might be the *T. ihringii* of Boulenger, but one of the principal characters of that species, as well as of the *T. alburnus* of Hensel, is that it has but 10 dorsal radii. The *T. obscurus* Hens. has the interorbital diameter equal the eye, and a vertical humeral spot.

TETRAGONOPTERUS PLIODUS sp. nov.

Form rather elongate, depth entering length (less caudal fin) three times; length of head entering the same four times. Maxillary bone extending beyond anterior border of orbit, supporting several tridenticulate teeth on its proximal portion. Eye large, much exceeding muzzle, entering length of head 2.25 times, and a little exceeding the interorbital width. Scales, $\frac{4}{35}{4}$. Radii, D. 10; A. 19; V. 9. Pectorals not reaching ventrals, nor ventrals the anal fin. Dorsal originating a little posterior to line of origin of ventrals. Silvery, with a broad, distinct, silver lateral band. No spots of any kind.

Total length, 70 mm.; length to base of caudal fin, 57 mm.; length to base of anal, 38 mm.; length to base of ventral (oblique), 26 mm.; length of head, 13 mm.

This is apparently a rare species, only two individuals being contained in the collection. It has many peculiarities, one of which is the possession of only ten rays in the dorsal fin. It shares this character with the *T. alburnus* of Hensel from the same region, but this species has 27 rays in the anal fin and the body is more elongate. It has some points in common with the *T. ihringii* (Boulenger, *Amer. Magaz. Nat. Hist.*, 1891, p. 172). Boulenger does not mention the maxillary teeth, which he could scarcely have overlooked. It has also one or two additional rows

of scales above the lateral line, and has the humeral and caudal spots, which are wanting in the *T. pliodus*.

HEMIGRAMMUS LUETKENII Boul. *Tetragonopterus luetkenii* Boulenger, *Ann. Mag. Nat. Hist.*, 1891, p. 173. *Chirodon luetkenii* von Ihring, *Süsswass. Fische v. Rio Grande do Sul*, 1893, p. 22.

Form deep ovate, outlines of body equally convex. Profile of front straight, a slight concavity above line of preopercle. Depth of body into length (less caudal fin), two and a half times; length of head into the same, four times. Eye large, its diameter greater than length of muzzle, a little less than interorbital width, and entering length of head 2.8 times. Scales, $\frac{5\text{–}5\frac{1}{2}}{\frac{32}{4\frac{1}{2}}}$. Radii, D. 11; A. 23. Pectorals not reaching ventrals, and ventrals not reaching anal. No teeth on the maxillary bone. Tubes of lateral line on eight to twelve scales. Dorsal fin originating a little behind vertical line of origin of ventrals. Color, silvery; a silver band on side. Humeral spot large, distinct, subround; caudal spot distinct, extending to extremities of median caudal radii.

Total length, 76 mm.; length, without caudal fin, 60 mm.; length to origin of anal, 40 mm.; length to origin of ventral (oblique), 29 mm.; length of head, 10 mm.

This species differs from the *H. robustulus* Cope in its more compressed head and in the absence of teeth on the maxillary bone. An abundant species in the Jacuhy.

CHIRODON MONODON sp. nov.

A single crenate tooth on the proximal extremity of the maxillary bone. General form rhombic oval. Depth in length, less caudal fin, 2.6 times; length of head in the same, 3.6 times. Eye large, its diameter exceeding length of muzzle, equaling interorbital width, and entering length of head 3 times. Scales, $\frac{5}{\frac{32}{4\frac{1}{2}}}$. Radii, D. 10; A. 19–22. Pectoral reaching ventral, and ventral nearly reaching anal. Origin of dorsal a little posterior to that of ventral. Lateral line extending on 9–10 scales. Silvery; an indistinct, narrow, dusky line visible on the middle of the side from the caudal fin to below the dorsal.

Total length, 46 mm.; length to base of caudal fin, 35 mm.; length to base of anal, 23 mm.; length to base of ventral, 15 mm.; length of head, 9 mm.

This small species has a scale formula about as in the *Hemigrammus ihringii*, but there is but one series of premaxillary teeth; there is a tooth on the base of the maxillary bone, and there are only ten dorsal rays. The number of anal rays is somewhat variable. Of the three specimens, one has 19 rays, the second 20, and the third 22. This is a deeper bodied form than the *C. pisciculus* Gird., and the only other spe-

cies, *C. interruptus* Jen., is said to have 11 dorsal rays and no maxillary teeth.

DIAPOMA SPECULIFERUM, *Amer. Naturalist*, 1894, p. 67.

*Char. gen.*—Adipose fin present. . Dentition as in Tetragonopterus, *i. e.*, with two rows of denticulate teeth on the premaxillary bone and one row on the dentaries. Origin of the short dorsal fin entirely posterior to that of the ventrals. Anal fin elongate. Belly not keeled. The operculum produced posteriorly below the lateral line to an apex. Lateral line not complete. Nares close together. Inferior limb of external branchial arch without rakers.

This genus is allied to Hemigrammus, but has a peculiarly formed operculum, which displays a tendency towards the character which is so much developed in Corynopoma Gill.*

*Char specif.*—Form rather elongate, the depth entering the length 3.25 times (less caudal fin). Length of head entering the same 3 6 times. Maxillary bone elongate, reaching the line of the anterior border of the pupil, supporting 4–5 teeth at its proximal end. Eye large, its diameter exceeding the length of the muzzle, equaling interorbital width, and entering length of head three times, one diameter equaling the long horizontal diameter of the operculum and suboperculum. The latter two elements form a subtriangular plate, of which the long diameter is horizontal, and of which the base is continued as a process along the posterior border of the preoperculum. The apex of the triangle is formed by the extremity of the suboperculum, and is obtuse. Scales, $\frac{4}{37}$ / 5; lateral line pores and tubes present on ten scales behind the epiclavicle, and on eight scales anterior to the caudal fin. Radii, D. 1.9 ; A. 2.29 ; V. 7 ; P. 11. Pectorals just reaching ventrals, and ventrals not reaching anal. Caudal deeply emarginate, a curved patch of scales extending on the inferior lobe from the base. Anal fin with its free border concave, the anterior rays longer than the posterior, and the posterior longer than the middle rays.

Sides, excepting the dorsal portion and that part adjacent to the anal fin, with a mercury-like metallic surface ; the operculum most brilliantly refulgent, the cheeks little less so. A straight leaden line from the head to the base of the caudal fin. No spots.

Total length, 45 mm.; length to base of caudal fin, 36 mm.; length to base of anal, 22 mm.; length to base of ventrals, 17 mm.; length of head, 10 mm.; length of head to preoperculum, 6 mm.

But one specimen of this curious little fish was sent by Mr. Smith. It is the most brilliant of the Characinidæ known to me.

*This genus received several names from Prof. Gill at the same time. Of these, Dr. Günther selected Corynopoma, as he had a right to do, and he has been followed in this by most other ichthyologists. One of the other names cannot therefore be now selected for this genus because it was printed on a previous page, as has been recently proposed.

CURIMATUS GILBERTII Q. and G.

Numerous specimens.

### STERNOPYGIDÆ.

CARAPUS FASCIATUS Pallas.

STERNOPYGUS VIRESCENS Val.

Apparently abundant.

## NEMATOGNATHI.

### SILURIDÆ.

RHAMDIA SAPO Val.

Five specimens which agree with the description given by the Eigenmanns, except in the possession of narrower bands of premaxillary and dentary teeth. The premaxillary patch is five times as long as wide.

RHAMDELLA STRAMINEA sp. nov.

Surface of posterior cranial bones fossate, but covered with a thin skin. Fontanel reaching base of supraoccipital process, with a narrow bridge opposite the posterior border of the orbit. Adipose fin entering the length (to base of caudal) five times, and equal to depth of body; length of head entering total, four times. Upper lip projecting a little beyond lower; tooth band in both jaws wide; teeth well developed. Eye 4 times in length of head to angle of operculum; one and a third times in interorbital width, and one and a half times in length of muzzle. Centre of pupil nearer end of muzzle than opercular angle. Maxillary barbels reaching middle of ventral fins; external mentals reaching base of pectoral fins; middle mentals half as long as externals. Dorsal spine rather slender, elongate, toothless; pectoral spine more robust, longer than soft rays, with eight robust spines on its internal border, and more numerous smaller dentations on the anterior border, which are not recurved. Radii, D. I 6; A. 13; P I. 8. Caudal fin deeply emarginate, the superior lobe a little longer than the inferior.

Total length, 85 mm.; length to base of caudal fin, 68 mm.; length to base of anal, 50 mm.; length to base of ventral, 33 mm.; length to base of pectoral, 19 mm. Length of head to apex of supraoccipital process, 21 mm.

Color in spirits, brownish straw-color, with silvery opercle, rather sparsely dusted with black specks. Adipose fin dusky bordered.

Five specimens of this species, which approaches the *R. jenynsii* Gthr., according to the detailed description given by the Eigenmanns. That species is said to have the eye only one-fifth the length of the head, and the adipose fin is one-fourth the total length. The occipital process is said to be covered with a thick skin. In the *R. straminea* this process is rugose and is covered by a very thin skin, and approaches quite near to the dorsal plate. From the *R. eriarcha* E. and E., from the Uraguay

river, this species differs in the proportions of the eye and head, the much longer barbels, much shorter adipose fin, etc.

PIMELODUS NIGRIBARBIS Blgr., *Proceeds. Zoöl. Soc.*, London, 1891, p. 232, Pl. xxv, Fig. 1.

Several specimens.

LORICARIA CADEÆ Hensel, *Archiv. f. Naturgesch*, 1868, p. 369.

Represented by four specimens of rather small size. The muzzle is depressed and is acuminate when viewed from above, and its length from the orbit enters the length of the head to the posterior extremity of the occipital plate two and a half times. The edges of the muzzle are hispid but not bristly. The abdomen is covered with a continuous series of scales, of which the lateral are elongate and directed forward, and the median smaller and in two rows. Those between the ventrals are distinct but solidly united, and there is a single anal which is notched in front for the anus. The scuta of the nape are furnished with obtuse keels, one on each side, which form a pair of ridges which converge forwards and are continued on the occipital plate until they approach quite closely. They then diverge and terminate above the postorbital plate. The third median nuchal plate is not ridged, but a lateral plate which joins it and the second nuchal on each side has a keel. There is no keel posterior to this, nor any between it and the superior keel of the lateral line. The space between the nostrils forms a median narrow ridge which bifurcates posteriorly, each half disappearing above the middle of the supraorbital border, from which it is separated by a groove, which is a posterior continuation from the nareal fossa. The central premaxillary ridge is divided by a narrow median groove, and a shallow groove bounds the lateral plates on each side, terminating in a preorbital fossa. Scales of lateral line, 28–29; the lateral keels uniting on the eighteenth scale. Diameter of eye, without the shallow notch, entering length of head 5.5 times and interorbital width 1.25 times.

The length of the head to the end of the occipital plate enters the length (less the caudal fin), 5.25 times; and the width of the head enters its length 1.4 times; the depth of the head enters the length of the same twice. Premaxillary jaws not separated by an emargination, but firmly united. Teeth, $\frac{6}{7}$. Lips coarsely and shortly fringed all round, the posterior coarsely tubercular and not notched posteriorly. Beard shorter than diameter of eye. The dorsal spine enters the total length (less caudal fin) 4.25 times, and the anal spine enters the same 5.6 times. Radii, D. I. 7; P. I. 6; V. I. 5; A. I. 5. The pectoral fins just reach the ventrals, and the ventrals the anal. The marginal rays of the caudal are not stronger than those of the other fins. Its border is concave, and the superior apex is a little longer than the inferior, and it is without filamentous prolongation.

Color light brown above, yellowish below. Five brown cross-bands on

the dorsal region and one on the nape. Five obscure dusky spots on the lateral border of the head to the opercular fissure. Dorsal fin with a dark spot near the extremity. Caudal with a dark spot at each apex and two at the base. Anal, ventrals and pectorals dusky at the extremity.

Total length, 78 mm.; length to base of caudal fin, 66 mm.; length to base of anal fin, 31 mm.; length to base of ventral, 21 mm.; length to base of pectoral, 11 mm.; length to end of occipital plate, 15 mm.

The only species which it is necessary to compare with this one is the *Loricaria konopickyi* of Steindachner.* According to this author this species resembles the *L. cadeæ* in most essential respects. It has, however, two lines of keels between the dorsal spine and the lateral ridge, where none exist in the *L. cadeæ*, and the middle rows of abdominal scales are in five rows instead of three. The teeth are nine or ten instead of six or seven, and the keels of the lateral scales come together on the fifteenth instead of the eighteenth row. The muzzle enters the head length 2.5 times instead of twice. The *L. konopickyi* is from the Amazon basin.

*Loricaria lima* Kner, to which this species is referred as identical by Von Jhring, differs as follows: The head enters the length 4.66 times; the superior ray of the caudal fin is produced; the eye enters the head 7.5 times; the fins are spotted.

Loricaria spixii Steindachner, *Denkschr. Wien Akad. Wiss.*, 1881, 18; Pl. ii. Several specimens.

Hisonotus lævior sp. nov.

Form rather slender, the depth at the base of the first dorsal ray entering the length to base of tail, six times; and equaling the length of the muzzle anterior to the orbit. Eye small, entering length of head five times, and three and a half times in the nearly flat interorbital space. Venter not entirely covered with scales, there being a series on each side, and a row of smaller ones in the middle, separated from them by a naked space. Median series expanding into a shield just posterior to bases of ventral fins. Dorsal and ventral aspects of caudal region rounded. Scales posteriorly moderately hispid, smoother anteriorly; on the top of the head the prickles very small. Lower lip convex, with narrow margin, and coarsely tubercular surface.

Origin of dorsal fin a little posterior to line of origin of ventrals. Caudal fin with the inferior angle produced a little farther than the superior. Spines of fins only moderately hispid, except towards the extremities of the pectorals, where the prickles are coarser. Radii, D. I. 7; P. I. 7; V. I. 5; A. I. 5. Scales of lateral line, twenty-eight. The pectoral fins reach the middle of the length of the ventrals, but the latter do not reach the anal.

* *Denkschriften math. Wiss. Klass. Kais. Akademie d. Wissensch.*, 1879, p. 45, Pl. vi, Fig. 3, and Pl. vii, Fig. 1.

Color, light brown. The dorsal fin is sparsely and the caudal fin is closely spotted with blackish, and the spinous rays of both are light colored with dusky spots.

Total length, 52 mm. ; length to basis of caudal fin, 41 mm. ; length to base of anal, 25 mm. ; length to base of ventrals, 16 mm. ; length to line connecting bases of pectorals, 10 mm.

A single specimen from the Rio Jacuhy, Rio Grande do Sul.

This is the third species of the genus now known, the one first described being the *H. notatus* of Eigenmann.* This species is said to be characterized by the presence of a triangular posterior process of the occipital element, and by the compressed and elevated form of the head ; characters not seen in the present species. The orbit is smaller, but the interorbital space is only as wide as three of its diameters. It has only twenty-five plates of the lateral line. The *Hisonotus nigricauda* † of Boulenger differs in the twenty-five plates of the lateral line, the I. 5 pectoral rays, the more numerous rows of ventral plates and the larger eye.

HISONOTUS LEPTOCHILUS sp. nov.

Form rather slender; head rather depressed. Depth at first dorsal ray entering length to base of caudal fin, 5.5 times. Eye small, entering length of head 5.5 times, and three times on the rather flat interorbital space. Venter covered with from ten to twelve rows of scuta, a single row on each side anteriorly, larger than the others. Caudal region rounded above and below. Hispid everywhere, especially on the supertemporal region. Three transverse and a median rhombic scuta between the occipal scute and the base of the dorsal spine. Lower lip thin, with thin transverse posterior margin and inconspicuous tubercles.

Dorsal fin originating a little posterior to ventrals. Pectorals reaching middle of ventrals; ventrals barely reaching anal. Inferior angle of caudal fin a little longer than the superior. Radii, D. I. 7 ; P. I. 6 ; V. I. 5 ; A. I. 5. Scales of lateral line, 28.

General color dusky, with numerous small pale spots everywhere, most conspicuous when the fish is immersed in fluid. Fins lighter, conspicuously spotted with dusky.

Total length, 54 mm.; length to base of caudal fin, 44 mm. ; length to base of anal, 35.5 mm. ; length to base of ventrals, 17.5 mm. ; length to base of pectorals, 10 mm. ; interorbital width, 6 mm.

The important characters which distinguish this species from the *H. lævior*, are the thin and truncate lower lip with feeble tuberculation ; the numerous ventral plates ; the narrower interorbital space, and the greater hispidity, especially of the head. It differs from the *H. notatus* in much the same way as the *H. lævior*.

* "Revision of South American Nematognathi," *California Acad. Sciences*, 1890, p. 391.

† *Proceeds. Zoöl. Soc.*, London, 1891, p. 234.

Hisonotus nigricauda Boulenger. *Otocinclus nigricauda*, Boul., *Proceeds. Zoöl. Soc.*, London, 1801, p. 234; Pl. xxv, Fig. 3.

One specimen. This species differs from those described above, in the presence of only two nuchal scuta between the occipital bone and the base of the first dorsal ray, as represented in Boulenger's figure. In this point it agrees with the two species of Otocinclus to be described below. In the two species of Hisonotus referred to, there are four nuchal plates crossing the same space.

The specimen of *H. nigricauda* measures, only 30 mm. The sides and posterior two thirds of the middle line of the belly are squamous, the remainder smooth.

Otocinclus flexilis sp. nov.

Head large, muzzle rather short, width posteriorly equal depth of body at first dorsal spine, and entering the length less the caudal fin four and a quarter times. Eye entering length of head four times, and interorbital width three times. Body compressed; superior and inferior aspects of caudal peduncle flattened, and separated from sides by an angular keel. Surfaces everywhere hispid. Perforations of supratemporal plate numerous. Lower lip very thin, and entirely smooth. Plates of belly in two lateral rows which are directed forwards, and are separated by a single row on the middle line, which is sometimes more or less incomplete, thus permitting those of the lateral series to come in contact. Occipital plate angulate posteriorly, and separated from dorsal spine by two transerse plates and a small median posteriorly.

The pectoral spines reach the base of the ventral fins, and the ventrals fall considerably short of the anal. Caudal lobes acute, subequal. Radii, D. I. 7; P. I. 6; V. I. 5; A. I. 5. The spines are all strongly hispid, and those of the pectoral fin are more robust than that of the dorsal. Plates of lateral line, 25.

Light yellowish brown, with a row of about six oblong dusky spots along the lateral line, which become obscure anteriorly. A series of corresponding spots along the dorsal region. Dorsal and caudal fins light colored with numerous dusky spots. A black spot at the base of the caudal fin in some specimens.

Total length, 56 mm.; length to base of caudal fin, 43 mm.; length to base of anal, 27 mm.; length to base of ventral, 19 mm.; length to base of pectoral, 10 mm.; length of head, 10 mm.; interorbital width, 7.5 mm.

This species need only be compared with the *O. affinis* of Steindachner, which is found near to Rio de Janeiro. That species has a posterior tuberosity of the occipital plate which is wanting in this species, and Steindachner represents only one entire plate between the occipital and the base of the dorsal spine. This region is more depressed in the *O. flexilis*, and the body is considerably more compressed, from the dorsal to

the caudal fins. The eye is also smaller than in the *O. affinis*. The lip is even weaker than in the *Hisonotus leptochilus*.

Rio Jacuhy, Rio Grande do Sul; numerous specimens.

OTOCINCLUS FIMBRIATUS sp. nov.

Form moderately stout; depth at base of D. I. entering length without caudal fin, four times. Head rather depressed with the muzzle rounded, entering the length (measured to opercular border) three and a half times. Eye entering length of head 4.25 times, and the flat interorbital space 2.75 times. Posterior lip well developed, coarsely tubercular, its border, together with the border of the anterior lip and the inner edge of the beard, fringed with obtuse processes. Occipital plate with acute apex, separated from base of dorsal spine by two transverse plates and a small median posterior one. Venter with three series of scuta; a lateral series of long ones directed forwards on each side, and a row of median scuta in contact with them. Scales everywhere hispid. Supratemporal perforations small, numerous, but concealed by the integument. Inferior and superior aspects of caudal region flattened, and separated by an angular keel from the sides.

Origin of dorsal fin immediately above that of the ventral. Caudal lobes acute, equal. Radii, D. I. 7; P. I. 6; V. I. 5; A. I. 5. Pectorals reaching a little beyond base of ventrals; latter barely reaching base of anal. Twenty-five rows of scuta in lateral line.

Color, light reddish yellow. There are four large dusky spots along the lateral line, the anterior enlarged and obscure. A series of corresponding dorsal spots. Caudal fin with three vertical dusky bars, which are sometimes broken into spots. Other fins with a dusky spot at base; the anal and dorsal with the spinous ray entirely dusky. Below, straw color.

Total length, 38.5 mm.; length to base of caudal fin, 28 mm.; length to base of anal, 18.5 mm.; length to base of ventral, 13 mm.; length to base of pectoral, 7.5 mm.; interorbital width, 5.5 mm.

This is the smallest of the Siluridæ here described, and is to be compared with the *Otocinclus affinis* already mentioned. The angulation and elevation of the nuchal region described by Steindachner as characteristic of that species are here wanting, and the fringe of the lips is not figured nor described by him. The eye is considerably smaller, entering the length of the head to the apex of the occipital shield 5.5 times instead of four times. In the *O. affinis* there is a longitudinal lateral band instead of spots, and the fins are not represented as spotted, as is the case with the *O. fimbriatus*. As compared with the *O. flexilis*, the *O. fimbriatus* differ greatly in the tubercular and fringed lip, relating to it in this respect much as the *Hisonotus lævior* does to the *H. leptochilus*. It is a smaller species than the *O. flexilis*, and is more brightly colored and with less numerous lateral spots. The ventral fins are relatively longer, and the

dorsal fin originates above their base, and not behind it, as is the case in *O. flexilis*.

Rio Jacuhy, Rio Grande do Sul ; numerous specimens.

In the many specimens of this species and the *O. flexilis* in the collection, the adipose fin spine is constantly wanting.

PLECOSTOMUS COMMERSONII Val.

One adult specimen. A young individual, which I suppose to belong to this species, exhibits the following characters :

Scuta not connected with each other anterior to the posterior border of the dorsal fin, and consisting of a median ossification only, each scute supporting a median comb of bristle-like teeth, which is longitudinal on most of them and is directed obliquely upwards posteriorly on the superolateral series. Besides the central comb, each scute has a shorter one near its superior and inferior extremities. Inferior surface, as far as the vent, without granules or scales. Scuta of lateral line, 28. Traces of a longitudinal angle on the posterior part of the supratemporal plate, and of two near together on the posterior part of the occipital. Head marked with coarse granular ridges, which are little marked on the suborbital and interorbital regions, and are replaced by fine lines on the anterior part of the occipital plate. Muzzle acuminate oval, viewed from above ; tip naked ; sides without bristles. Occipital bounded posteriorly by a single nuchal plate, which is separated from the basal dorsal fin plate by a second nuchal. Lip large, entire, coarsely tubercular. Teeth about $\frac{18}{15}$ on each side. The humeral angle extends on two plates only.

Fin radii, D. I. 7; P. I. 6 ; V. I. 5 ; A. 5. The eye enters the length of the head to the apex of the occipital plate six times, three times in the muzzle, and 2.25 times in the interorbital space, which is plane. The base of the dorsal fin is as long as the space from its posterior ray to half way between the adipose fin and the base of the caudal. The pectoral extends a little beyond the base of the ventral, and the ventral to a short distance beyond the posterior ray of the anal fin. The inferior apex of the caudal fin is considerably longer than the superior.

Total length, 47 mm.; length to base of caudal fin, 34 mm.; length to base of anal fin, 23 mm.; length to ventral, 17 mm.; length to base of pectoral, 9 mm., length of head to apex of occipital plate, 13 mm. Color in alcohol, reddish brown, an obscure dark shade about the base of the dorsal fin. A single row of dusky spots in each membranous space of the dorsal fin. Caudal fin with about three oblique vertical cross-rows of rufous spots.

The single specimen on which this description is founded is probably young, yet various indications point to its being of small size at maturity. The well-developed lip and tubercles are those of a mature fish, and the relatively small size of the eye indicate that little change is to be looked for in the proportions of the head. It is probable that the deficient ossification of the anterior body plates is a character of immaturity.

PLECOSTOMUS ASPILOGASTER sp. nov.

Head with three obtuse angles; the lateral extending posterior to the orbits; the median obscure between the orbits, but distinct on the occipital plate. Belly covered with granular scales which are collected into indistinct scuta posterior to the lip. Posthumeral ridge short, covering only four or five scuta. Besides this, the scuta are not keeled, but are distinctly angular on the dorsolateral and ventrolateral rows, and traces of keels exist on the anterior scuta of the two median lateral rows. Occipital plate bounded posteriorly by two scuta which are obtusely angulated, and these are separated from the base of the dorsal spine by three transverse nuchal plates, each of which has an obtuse lateral angle of the surface. There is a naked patch on the end of the muzzle, which does not reach the superior surface. Eye small, entering length of head eight times, muzzle five times, and interorbital space 3.75 times. Lateral line of scuta, 30. All the scuta are rough with longitudinal ridges, but they are not very spinous. Inferior and superior surfaces of caudal peduncle flattened. Length of head entering total (without caudal fin), three and one-third times.

Base of dorsal fin equal space between its posterior ray and a point half way between adipose and caudal fins. First dorsal ray equal length of head; shortest caudal rays equal from end of muzzle to posterior border of orbit. Radii, D. I. 8 in three specimens, I. 9 in one; P. I. 6; V. I. 5; A. 5. Pectoral extending to basal third of ventral; ventral to posterior border of anal. Teeth $\frac{40}{42}$ on each side the terminal portion elongate, amber-colored. Length of median caudal rays .66 of length of head.

Total length, 250 mm.; length to base of caudal fin, 198 mm.; to base of anal, 122 mm.; to base of ventral, 82 mm.; to base of pectoral, 41 mm. Length of head to posterior border of occipital plate, 54 mm.; width of head at opercular fissure of lateral angle, 49 mm. Length of specimen with dorsal radii I. 9, 275 mm.

Color above, dark brown, spotted anteriorly with dusky; below unspotted light brown. There are two or three dusky spots on each scuta, but these are not visible posterior to the dorsal fin. The head is closely spotted with very small dusky spots, which are large and more distinct on the supratemporal region, where they have a diameter of about a millimeter and are separated by spaces of about the same diameters. The dorsal fin is coarsely spotted with dusky, there being one or two rows on each interspinous membrane. The pectorals, ventrals and anal are similarly spotted, with a single row between the spines, and the caudal fin is unspotted.

In general proportions, and in the fin and scale formula, this species resembles the *P. commersonii*, but in various other respects it apparently resembles the *P. carinatus* of Steindachner. It differs from this species in the very obscure or absent carination, in the much smaller eye, and in the shorter base of the dorsal fin, according to its describer. It is from

the Jutahy in Western Amazonia. The four specimens of the *P. aspilogaster* before me are from the Jacuhy, Rio Grande do Sul. This species also approximates the *P. limosus* Eigenm. (*Proceeds. Calif. Acad. Sci.*, 1888, pp. 167–8), from the Uraguay R. According to the description this species has the occipital plate bordered by a single nuchal instead of by three, and the middle rays of the caudal fin are nearly equal to the length of the head. The postdorsal region should be rounded above and below, whereas it is flattened, and the fins and belly are spotted. In the *P. aspilogaster* the caudal fin and belly are without markings.

The *Plecostomus virescens* Cope (*Proceeds. Academy, Philadelphia*, 1874, p. 137) was founded on young individuals from Eastern Peru. The Eigenmanns state their inability to locate it in their system of Nematognathi. In their table of the genus Plecostomus (*l. c.* p. 398) is a section which includes species with the ventral integument more or less scaleless, a character which Boulenger alleges to be more or less untrustworthy. In any case two specimens of the *P. virescens* of 60 mm. in length have the belly smooth. In one of 70 mm. a few granules appear on the median line of the belly. In one of 92 mm., a band of granules extends from the anus to the coracoid bridge on the middle line spreading and fading out laterally on the belly. Supposing the latter character to be retained to maturity (which is uncertain) the *P. virescens* differs from the species referred to the section with naked bellies by the Eigenmanns. Disregarding the squamation of the belly, the former enters the section which includes the *P. bicirrhosus*. The l.l. is 26–7. Superciliary borders a little raised. The triangular part of the occipital bone is bordered by two scuta on each side, and one scutum which touches the apex, and none of them are angulated. Body scales not keeled. The base of the dorsal equals its length from the adipose fin. A few small spines at the inferior opercular angle. Head and body unspotted. All the fins spotted. Apparently nearest the *P. villarsii* Luetken.

CALLICHTHYS TAMOATA Linn.

CORYDORAS PALEATUS Jenyns. *C. marmoratus* Steind., *Denkschr. K. Akad. Wien*, 1879 (see Pl. v, Fig. 1); good figure.

About sixty specimens, varying in length from 35 mm. to 70 mm. I have examined about fifty of these in order to ascertain whether there is any variation in the degree of extension of the coracoid bones over the pectoral region. There is no variation, that of each side remaining widely separated from the corresponding one of the other side in all the specimens. Not having met with any variation in any of the species in this respect, I distinguished the species where the pectoral region is enclosed below by the coracoids, as a distinct genus, retaining for it the name Corydoras, and naming the series with naked breast, Gastrodermus.* According to Eigenmann,† the type of Corydoras, *C. punctatus* L., possesses

* *Proceeds. Amer. Philos. Soc.*, 1878, p. 681.

† *Revision of S. Amer. Nematognathi*, 1890, p. 465.

the character which I have assigned to Gastrodermus, which is therefore the true Corydoras. It therefore becomes necessary to give the genus with armored thorax a new generic name. This I propose shall be Osteogaster. The type is the *Corydoras eques* of Steindachner, and the only other species which can be positively assigned to it is, according to Eigenmann, the *C. splendens* Castelnau.

## ICHTHYOCEPHALI.

Prof. Gill has called my attention to an error which occurs in my paper on the classification of fishes published in 1871, in the exchanged places of the genera Monopterus and Symbranchus. The characters of the one are by an inadvertence ascribed to the other, by an accidental exchange of the names.

### SYMBRANCHIDÆ.

SYMBRANCHUS MARMORATUS Bloch.

## HAPLOMI.

### CYPRINODONTIDÆ.

GIRARDINUS CAUDIMACULATUS Hensel., *Arch. f. Naturgesch.*, 1870, p. 362; Von Jhring. *Süsswasserf. v. Rio Grande do Sul*, 1893, p. 28.

Depth of body a little greater than length of head. Dorsal fin originating above middle of anal. Scales 28–8. Radii, D. I. 7; A. 10. Eye one-third head, exceeding length of muzzle, and 1.5 times in interorbital width. Scales between interorbital space and dorsal fin, 18. Yellowish with a black vertical spot on the thirteenth scale from the caudal fin.

## PERCOMORPHI.

### CICHLIDÆ.

CRENICICHLA LEPIDOTA Heckel; Steindachner, *Sitzber. K. Wien Akad. Wiss.*, 1874, p. 22.

Numerous specimens; evidently the common perch of the Jacuhy.

CRENICICHLA LACUSTRIS Cast.; Steindachner, *Sitzber. K. Wien Akad. Wiss.*, Dec., 1874, p. 18.

Form elongate, body compressed; profile gently decurved from the first dorsal ray to the upper lip, which is less produced than the prominent mandible. The length of the head is contained in the total 3.66 times, and into that of the head and body three times. Depth of body contained in total 5.5 times, and into that of head and body 4.5 times. Eye not large, entering length of head 6.5 times; twice in muzzle without chin, and 1.6 times in interorbital space, which is slightly convex transversely. Scales $\frac{7\text{–}9}{22}$; those of the lateral line fewer than those of the transverse rows, for the reason that on the anterior part of the body one lateral line scale is bounded by three scales of the transverse rows, and

on the posterior part of the body, one lateral line scale corresponds to two transverse rows. Thus the transverse rows number 72, while there are only 40 in the lateral line. Fin radii, D. XX. 12; A. III. 9; V. I. 5; P. 17. Color brownish above and yellowish below in alcohol. Sides of body and head with dorsal and anal fin rather sparsely spotted with small black spots. A much larger black spot at the base of the caudal fin, which is not light bordered. A black band from the eye, the opercular border, and another very distinct one from the eye downwards across the cheek. Paired fins uniformly yellowish.

Total length, 196 mm.; length to base of caudal fin, 168 mm.; length to base of anal, 115 mm.; length to base of ventral, 89 mm.; length to base of dorsal (axial), 53 mm.

The number of transverse rows of scales is intermediate in the genus, while the number of those traversed by the lateral line is smaller than is mentioned by authors as occurring in any known species. The prominence of the lower jaw approximates a character of the *C. lucius* Cope, of the upper Amazon, but in that species the top of the head is flat and horizontal and not convex and decurved. The scales are also larger.

But three specimens of this fish were taken by Mr. Smith. The smallest measures 137 mm. in total length and differs as a younger individual in the larger eye, which enters the head 4.75 times, and equals the interorbital width. Radii, D. XXII. 13; A. III. 9. Scales $\frac{9}{\frac{11}{22}}$, the transverse series twice as numerous as those of the lateral line posteriorly, and three times as numerous anteriorly. Besides the black specks there is a row of eight dusky spots on the side of the body.

GEOPHAGUS GYMNOGENYS Hensel., *Arch. für Naturgesch.*, 1870, p. 61; Von Jhring, *Süsswasser Fische von Rio Grande do Sul*, 1893, p. 31.

I find four species of *Geophagus* in the Smith collection, which differ as follows:

*a*. Cheeks naked or nearly so.

Profile nearly straight; eye one-third head; caudal fin emarginate; anal soft rays, 8; body oval; smaller.................... *G. gymnogenys*.

Profile of skull strongly convex at orbit; eye one-third head; outline of body contracting from first dorsal spine posteriorly; caudal fin truncate; anal soft rays, 8; smaller........................ *G. camurus*.

*aa*. Cheeks scaly.

Profile straight, preorbital bone wider; caudal fin truncate; anal with eight soft rays; eye one-fourth head; l. l., 25; smaller.. *G. brachyurus*.

Profile straight; preorbital bone much wider; eye more than four times in head; body oval; l.l., 28; anal with nine soft rays; caudal fin rounded; larger................................ *G. brasiliensis*.

In each of the four species of Geophagus here described, the inferior bounding fold of the inferior lip is interrupted at the middle line. The

lamelliform lobe of the first branchial arch is simple in the *G. gymnogenys*, in *G. camurus* and *G. brachyurus* its border is divided into digitate processes. In my specimen of *G. brasiliensis* the digitate processes are present but rudimental. Hensel has distinguished a species as characterized among other points by the absence of scales on the cheek. Steindachner does not appear to have met with this condition in the *G. brasiliensis*, yet he refers Hensel's species to the latter, believing that the absence of scales from the cheek is an abnormality, "probably most frequent during the spawning season." I find the character on the contrary to be constant in the eight specimens of *G. gymnogenys* and *G. camurus*, which are of different sizes and ages, and which are characterized by well-marked peculiarities of the form of the head and the body. The scales are constantly present in five specimens of the *G. brachyurus*, which are of the same size as those of the *G. gymnogenys* and *G. camurus*, and are associated with equally well-marked specific characters. I believe with Von Jhring that Hensel is right in regarding the character as of specific value.

In the *Geophagus gymnogenys* the anterior border of the orbit is as far from end of muzzle as the posterior border of the orbit is from the convexity of the opercular border. Profile nearly straight, dorsal fin not scaly at base. Cheek naked except a patch of five scales between the orbit and preopercle. Preorbital bone a little wider than tegumentary orbit. Scales $\frac{3}{\frac{28}{8}}$. Fin radii, D. XIII. 11; A. III. 8. Body deep; the depth contained in the length to base of caudal fin 2.33 times; length of head in the same, three times. Pectoral fin reaching first soft ray of anal; caudal fin openly emarginate.

Color brown, each scale with a paler centre. A dark-brown spot extends over the dorsum immediately in front of the dorsal fin and extends to the lateral line on each side. Two dark spots below the spinous dorsal fin, and two below the soft dorsal, above the lateral line. A dark spot below the lateral line behind the superior opercular angle, and another on the side below the rays xi and xii of the spinous dorsal. Dorsal and caudal fins dusky with rather numerous oval and round pale spots. A dark spot on superior part of operculum and one below eye.

Total length, 107 mm.; length to base of caudal fin, 87 mm.; length to base of anal, 53 mm.; length to base of ventral, 39 mm.; length of head side, 26 mm.

One specimen.

GEOPHAGUS CAMURUS sp. nov.

Anterior border of orbit more distant from end of muzzle than the posterior border is from convex border of operculum. Profile strongly convex at and in front of the orbit. Form most elevated at the base of the dorsal fin, then tapering posteriorly. Cheeks naked or with one or two obscure scales. Preorbital bone a little wider than tegumentary orbit.

Scales $\frac{3\frac{1}{2}}{\frac{28}{7}}$. Fin radii, D. XIV. 10; A. III. 8; two out of seven specimens with the dorsal spines XIII, and two with the soft rays of the anal 9. Caudal fin truncate. Greatest depth entering length, minus caudal fin, 2.5 times; length of head in same three times. Diameter of eye entering head three times. Pectoral fin reaching first soft ray of anal.

Color brown, each scale with a paler centre. The spotting is similar to that of the *G. gymnogenys* except that the dorsal region is dusky and without well defined spots, the saddle shaped black spot in front of the dorsal only remaining. Below the lateral line on the middle of the side is a strongly defined spot, and traces of one behind the epiclavicle are also visible. A dark bar below the orbit, which is absent from most of the specimens, which have been somewhat bleached by alcohol. Fins spotted as in *G. gymnogenys*.

Total length, 95 mm.; length to base of caudal fin, 72 mm.; length to base of anal, 48 mm.; length to base of ventral, 26 mm; length of head on side, 24 mm.

Seven specimens. This species is near the *G. gymnogenys*, but differs much in the form of the head and body, and in the number of the rays of the dorsal fin.

GEOPHAGUS BRACHYURUS sp. nov.

Anterior border of orbit about as far from the end of the muzzle, as from the convexity of the opercular border. Preorbital bone distinctly longer than diameter of tegumentary orbit. Profile straight, slightly concave at orbit. Form of body to caudal peduncle an oblong oval. Cheeks with five rows of scales below orbit. Scales $\frac{3\frac{1}{2}}{\frac{25}{8}}$. Fin radii, D. XIV. 9; A. III. 8. In two specimens the dorsal rays are XV. 9 and XIII. 10; and in the latter specimen the anal rays are III. 9; in a thin specimen the anal rays are III. 7. Caudal fin truncate. Greatest depth entering the length, minus the caudal fin, 2.2 times; length of head entering the same 2.75 times. Diameter of eye entering side of head four times.

Color in alcohol brown, the dorsal and anal fins blackish. The color of the spinous part of the former is varied by the presence of oblique spots of a pale color, which form stripes running upwards and backwards. These transparent spots are wanting on the anal fin. A black spot at base of first dorsal rays; another below the lateral line below the middle of the spinous dorsal and a black bar below the eye.

Total length, 97 mm.; length to base of caudal fin, 75 mm.; length to base of anal, 52 mm.; length to base of ventral, 35 mm.; length of head, 28 mm.

Five specimens. This species is well distinguished from the species previously described, by the smaller eye, and an abbreviation of the body

posteriorly. The latter character reduces the number of scales of the lateral line and alters the relative proportions generally. Thus the length of the caudal peduncle equals that of the preorbital bone to the orbit; in the *G. gymnogenys* it equals the length of that bone plus the diameter of the orbit. The coloration of the fins is also peculiar.

GEOPHAGUS BRASILIENSIS Quoy and Gaimard; Steindachner, *Sitzb. K. Wien Akad.*, 1871, December, p. 13.

Anterior border of orbit considerably farther from the end of the muzzle than the posterior border is from the convex edge of the operculum. The middle of the length of the head falls near the middle of the pupil. Profile straight and steeply descending. Preorbital bone 1.75 times as long as the diameter of the orbit. Cheeks with five rows of scales. Form of body oval, a little higher in front. Scales $\frac{4\frac{1}{2}}{\frac{28}{8}}$. Fin radii, D. XV. 11; A. III. 9. Greatest depth two and one-third times in length to base of caudal fin; length of head in same two and three-quarter times. Diameter of eye entering head 4.66 times, and twice in the interorbital width, measured over its strong convexity. Caudal fin rounded, truncate in the middle, its basal portion scaly throughout.

Color light brown in alcohol, each scale with a paler centre; a large black spot below the lateral line opposite the middle of the spinous dorsal fin. A few scattered pearl blue spots on the operculum and on the scales posterior to it. Caudal fin, spinous dorsal, and base of soft dorsal dusky; the caudal with oval transparent spots and the spinous dorsal with a few oblique transparent streaks, directed upwards posteriorly. A few round transparent spots at the posterior base of the soft dorsal. Paired fins unspotted, the anterior rays of the ventrals dusky.

Total length, 193 mm.; length to base of caudal fin, 153 mm.; length to base of anal, 102 mm.; length to base of ventrals, 58 mm.; length of head, 54 mm.

This species agrees with the *G. gymnogenys* and *camurus* in its scale formula, and with the *G. brachyurus* in its scaly cheek and coloration. It differs from all of them in the more posterior position of the eye and length of preorbital bone, and in the shape of the caudal fin. In some respects it agrees with the *Geophagus macrolepis* of Günther,* but in that fish the eye has a much more posterior position. There is but one specimen of the *G. brasiliensis* in the collection.

ACARA TETRAMERA Heckel *Brasil. Fluss-Fische; Ann. der Wien Mus.*, ii, p. 341. Steindachner *Sitzber. Wien Akad.*, 1875, January, p. 5.

Numerous specimens. Dr. Steindachner having endeavored to show that the *A. flavilabris* Cope, is identical with this species, I embrace the present opportunity of making a direct comparison. With five speci-

* *Catal. Fishes Brit. Mus.*, iv, p. 314.

mens of the *A. flavilabris* before me, I find that there are but two rows of scales on the cheek, one row on the inferior limb of the preopercle, and one on the interopercle, as I have figured and described. In *A. tetramera* there are three rows on the cheek, and none on the preopercle and interopercle, as described by Steindachner. The preorbital bone is only .66 the diameter of the orbit in *A. flavilabris*, as in the younger *A. tetramera*. The front between the orbits is absolutely flat in *A. flavilabris*, while it is convex at the borders in *A. tetramera*. All the specimens of *A. flavilabris* have XVI dorsal spines. In all the lower lip is conspicuously yellow, a character not present in the *A. tetramera* in my collection, nor described by authors. The absence of this characteristic mark is the only fault in my figure.*

ACARA AUTOCHTHON Gthr. Steindachner *Sitzber. K. Wien Akad.*, 1874, December, p. 4.

## SUMMARY.

The species enumerated in the preceding pages are distributed in families as follows :

| | Total. | New Genera. | New Species. |
|---|---|---|---|
| Clupeidæ | 1 | 0 | 0 |
| Characinidæ | 15 | 3 | 9 |
| Sternopygidæ | 2 | 0 | 0 |
| Siluridæ | 14 | 0 | 6 |
| Symbranchidæ | 1 | 0 | 0 |
| Cyprinodontidæ | 1 | 0 | 0 |
| Cichlidæ | 8 | 0 | 2 |
| Total | 42 | 3 | 17 |

Besides the addition of seventeen species to the fauna of the Jacuhy river, five genera are introduced. Four of these are Characinidæ, viz: Asiphonichthys, Chorimycterus, Diapoma and Pseudocorynopoma. Of these the first three are new to science, and the last has been previously known from the drainage of the La Plata only. The fifth genus is Sternopygus, which has not been enumerated by previous authors as found in the Jacuhy river.

## NOTE.

Mr. Smith obtained near Chapada in Matto Grosso from the head waters of the Paraguay, *Tetragonopterus lineatus* Steind. and *T. moorei* Boul. From the head waters of the Tocantins, not far from the same locality, he obtained a species close to the *T. caudimaculatus* Gthr.

* *Proceeds. Academy Phila.*, 1872, p. 255., Pl. xi, Fig. 4.

## EXPLANATION OF PLATES.

Figures all natural size unless otherwise stated.

### Plate IV.

Fig. 1. *Xiphorhamphus brachycephalus* Cope ; *a.* head from above.

### Plate V.

Fig. 2. *Asiphonichthys stenopterus* Cope.
3. *Chorimycterus tenuis* Cope.
4. *Diapoma speculiferum* Cope.
5. *Tetragonopterus pliodus* Cope.

### Plate VI.

Fig. 6. *Tetragonopterus jacuhiensis* Cope.
7. *Tetragonopterus laticeps* Cope.
8. *Tetragonopterus eigenmanniorum* Cope.
9. *Chirodon monodon* Cope.

### Plate VII.

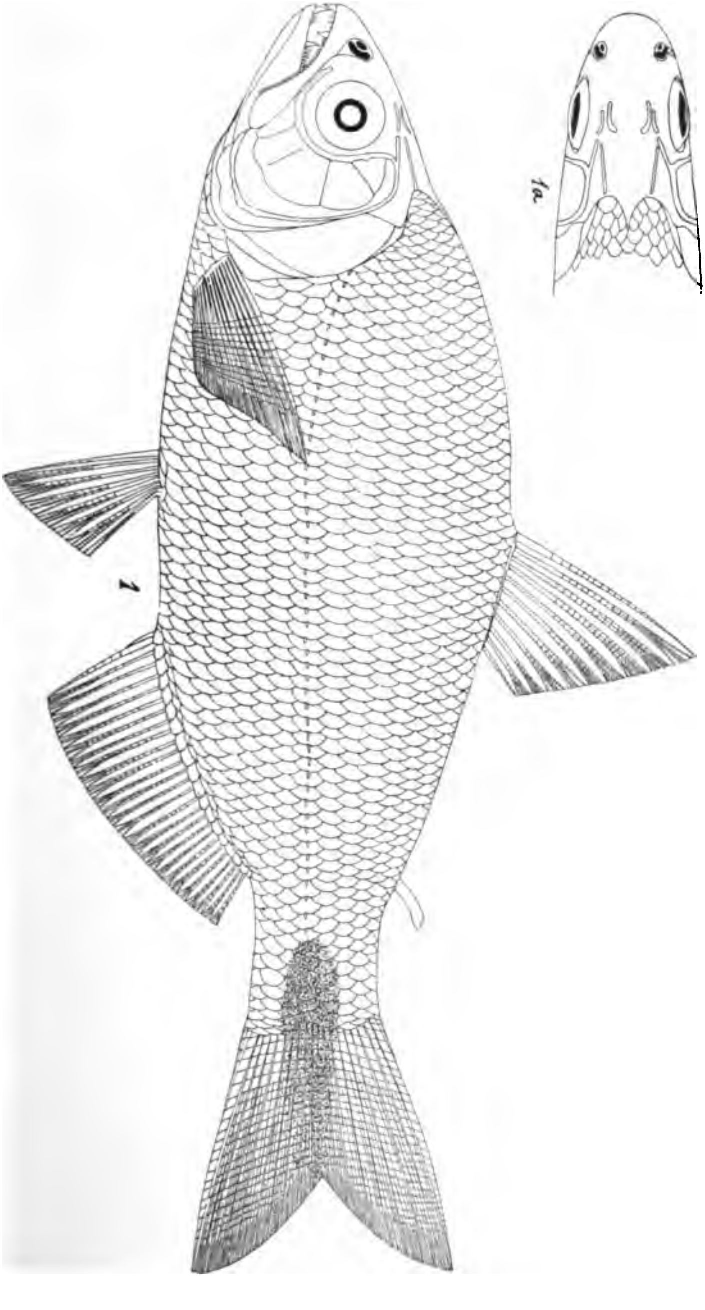
Fig. 10. *Rhamdella straminea* Cope.
11. *Hisonotus leptochilus* Cope. *a.* Head from above $\frac{3}{2}$ natural size ; *b.* Head from below.
12. *Hisonotus lævior* Cope. *a.* Head from above $\frac{3}{2}$ natural size ; *b.* Head from below.
13. *Otocinclus flexilis* Cope. *a.* Head from above $\frac{3}{2}$ natural size ; *b.* Head from below.

### Plate VIII.

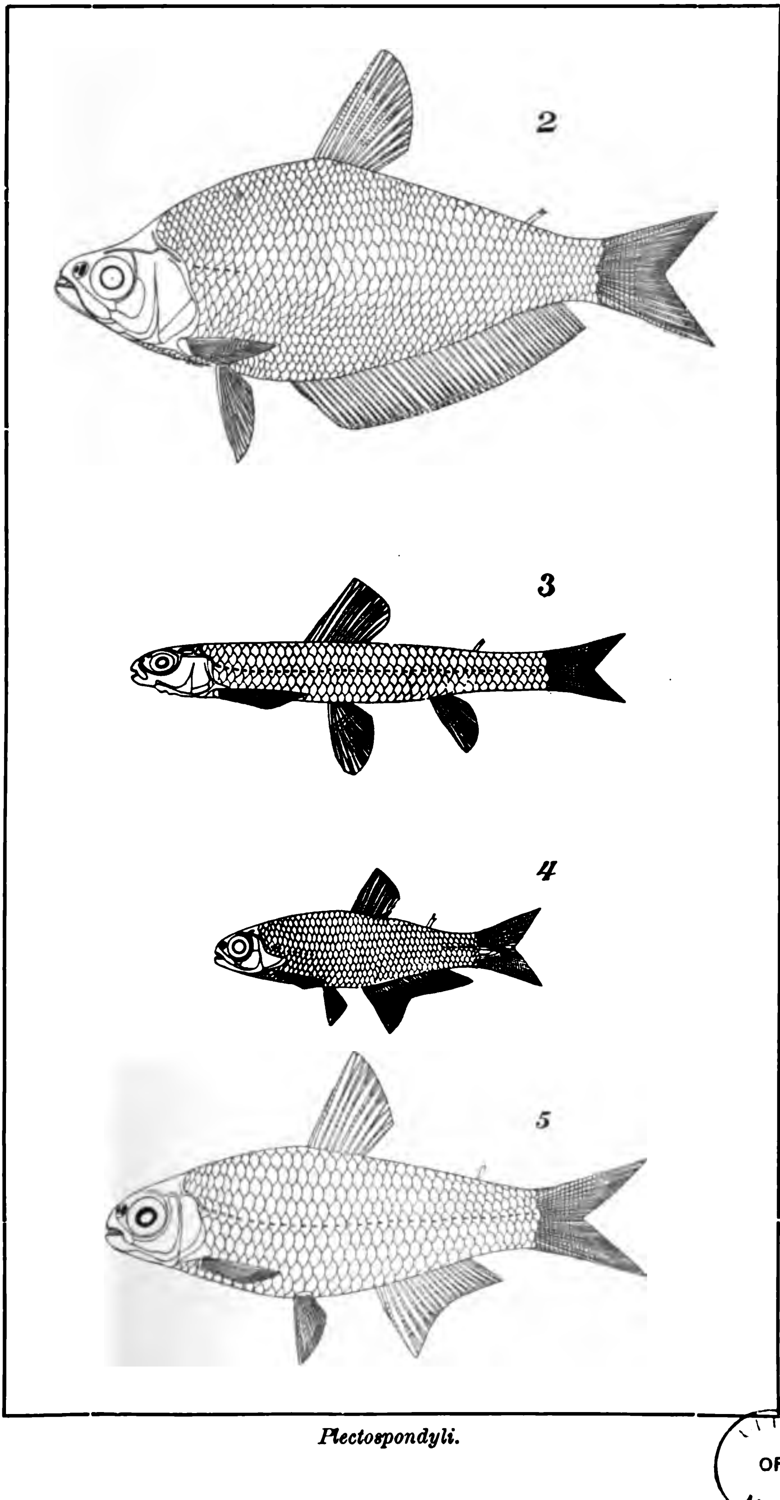
Fig. 14. *Plecostomus aspilogaster* Cope, $\frac{3}{4}$ natural size. *a.* head from below $\times \frac{3}{4}$.
15. *Loricaria cadeæ* Hensel, from side. *a.* From above ; *b.* From below $\frac{3}{2}$ natural size.

### Plate IX.

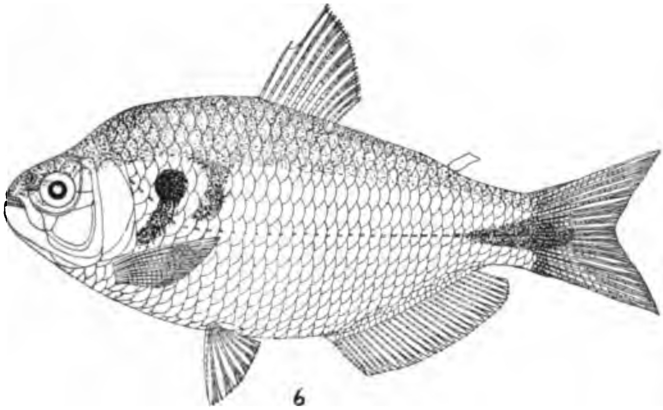
Fig. 16. *Otocinclus fimbriatus* Cope. *a.* Head from above $\times$ 2 ; *b.* Head from below $\times$ 2.
17. *Geophagus camurus* Cope.
18. *Geophagus brachyurus* Cope.




*Plectospondyli.*




*Plectospondyli.*



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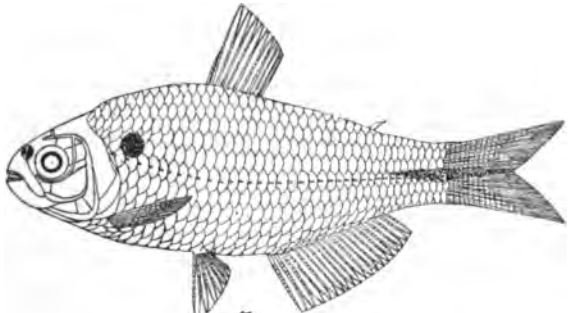

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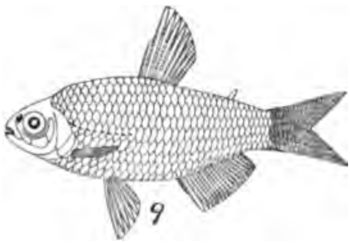

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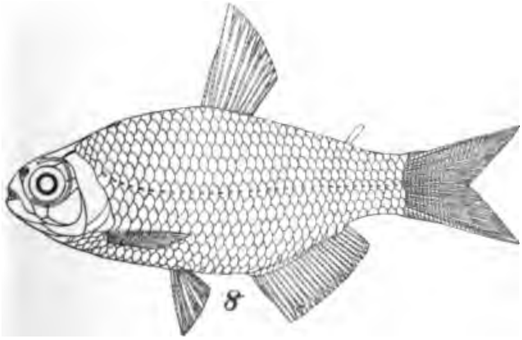

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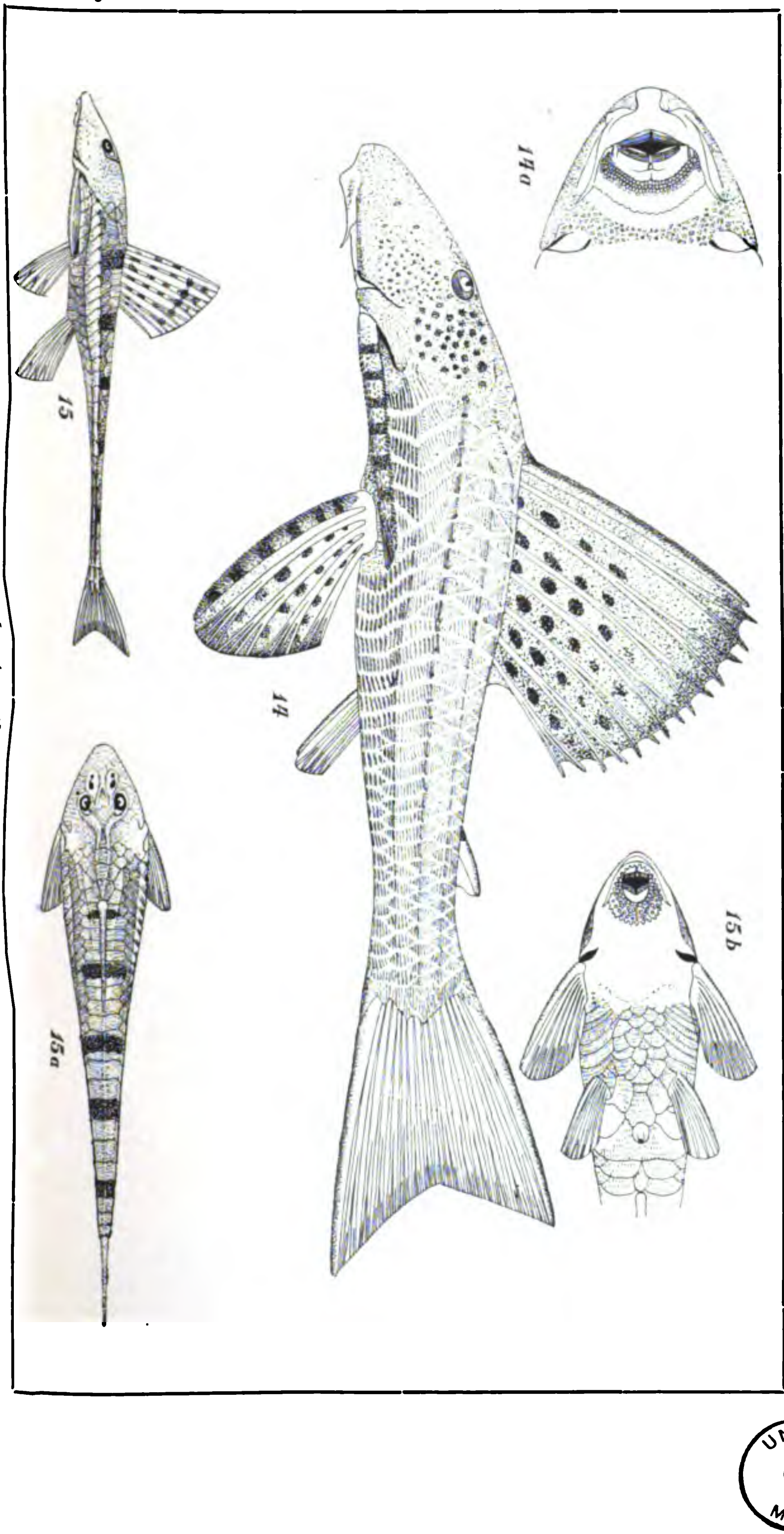
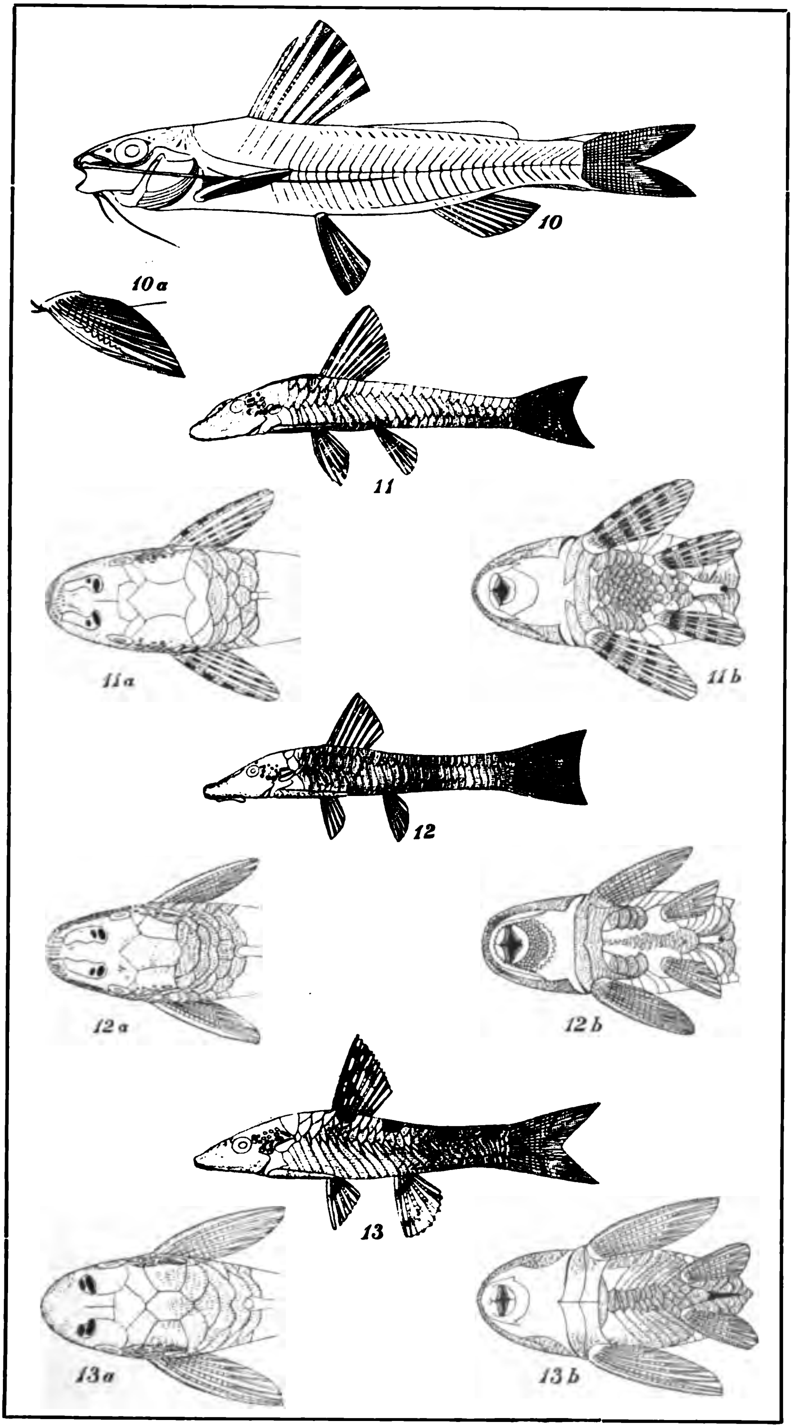
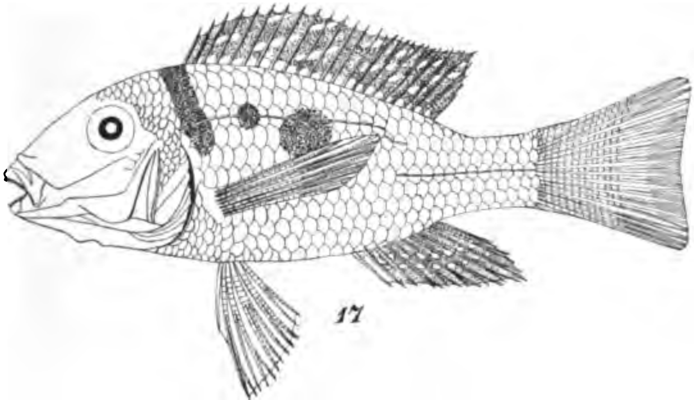
*Plectospondyli.*




*Nematognathi.*




*Nematognathi.*



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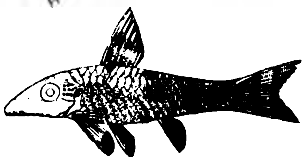

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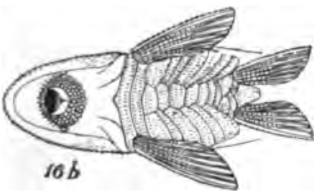

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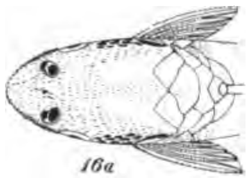

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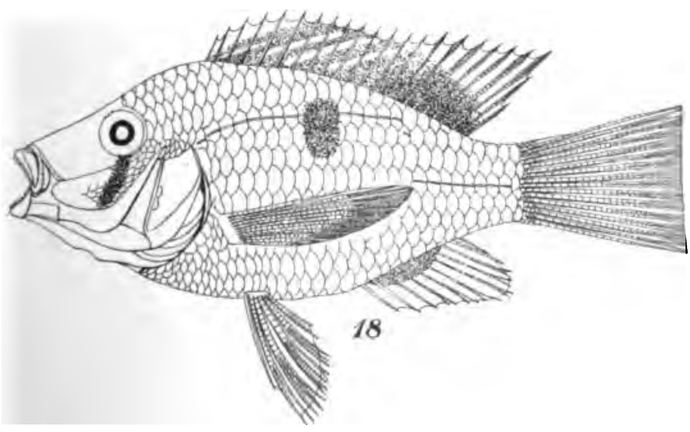

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*16. Nematognathi.* *17–18. Percomorphi.*

# *On the Structure of the Skull in the Plesiosaurian Reptilia, and on Two New Species from the Upper Cretaceous.*

*By E. D. Cope.*

*(Read before the American Philosophical Society, February 2, 1894.)*

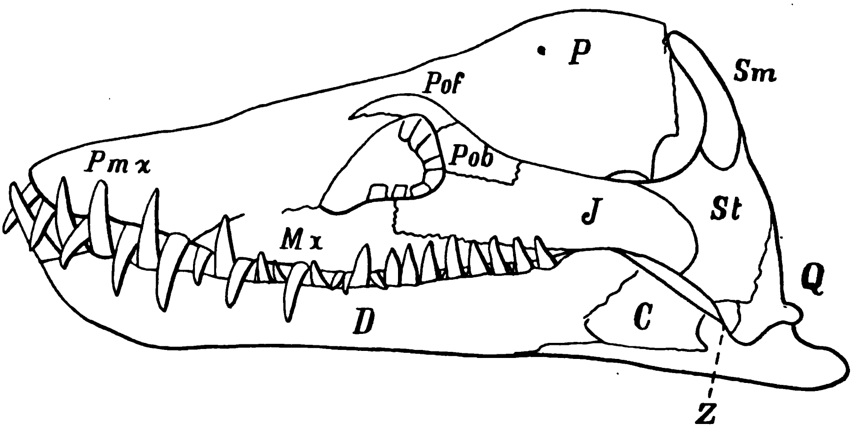
Prof. S. W. Williston has described in the *Proceedings of the Kansas Academy of Science* for 1890, the skull and part of the skeleton of a Plesiosauroid from the Niobrara Cretaceous of Kansas, under the name of *Cimoliasaurus snovii.* Through the kindness of Prof. Williston, I have had the opportunity to examine the specimen, and I have been able to make some observations on the structure of the skull, which supplies an important desideratum in our information on the subject.

In a paper in which I endeavor to trace the homologies of the cranial bars of the Reptilia,* I ascribe † to the Sauropterygia a single postorbital arch, and state that the available evidence is to the effect that this is the zygomatic. I remark, "The supratemporal has no anterior connections according to this author" (Von Meyer on Nothosaurus), "and the supramastoid is not described. From all that I can gather from Owen's figures and descriptions of Plesiosaurus, the structure is the same, which is confirmed by observation on such imperfect specimens as are accessible to me."

Examination of Williston's specimen shows that there is but one postorbital bar, and that this is partly the zygomatic, since it extends to the distal extremity of the quadrate, and encloses with it a small zygomatic or quadratojugal bone. But the posterior part of the arch includes also a large supratemporal, as in many Testudinata. Above the supratemporal, and forming the parietomastoid arch, is the separate element which I have referred to in the above quotation as supratemporal, but which it is now clear is the supramastoid. It is then homologous with the element in Ichthyosaurus and in the Cotylosauria, which I have called by that name. This discovery enables me to demonstrate the correctness of my supposition made in the paper already quoted (pp. 19–22), that the postero-lateral process of the parietal bone, so characteristic of Sphenodon and Lacertilia, really includes the supramastoid element. There is no question about the distinctness of this element from the parietal in the Cimoliasaurus, and the suture is shown in the outline figures given by Williston in his description referred to. The suture between it and the supratemporal is not so distinct, but is nevertheless visible. The following figure is copied from Williston, with the sutures inserted as I observed them.

* "On the Homologies of the Posterior Cranial Arches in the Reptilia," *Trans. Amer. Philos. Soc.*, 1892, p. 11.

† L. c., p. 21.




Posterior part of right side of skull of *Cimoliasaurus snovii* Willist. Modified after Williston.

I embrace the present opportunity to correct an error into which I inadvertently fell when naming the elements of the cranium in the Cotylosauria, in the essay above quoted. That segment which forms the lateral angle of the superior table of the skull in the Cotylosaurian reptiles, the Stegocephalous batrachians, and many fishes, is there termed the *os intercalare*, after Cuvier. It is, however, not his intercalare, but his external occipital. This is the epiotic of Huxley, but as it is not homologous with that element in the Reptilia, it requires another name. I propose that it be called the *os tabulare*, or the tabular bone. I do not know of any reptiles other than the Cotylosauria in which it is present ; (see Pl. x, *Tab.*).

I refer in this connection to a taxonomic question which depends on a correct knowledge of the posterior part of the Reptilian skull. Huxley * referred the Triassic genus Telerpeton to the Lacertilia, and I afterwards † endeavored to show that this genus, together with Rhynchosaurus, Hyperodapedon and Saurosternum belong to the Rhynchocephalia. In this I have been followed by most authors who have since treated of the subject. After a study of the cranial arches, I became convinced that these genera could not be Rhynchocephalia, ‡ since they possess but one postorbital bar, while the Rhynchocephalia possess two. In the papers cited below I placed them in the Theromora in the subdivision Proganosauria, and associated with them the Proterosauriidæ. It has become evident that this is their true position, and that they are not far removed from the Anomodontia, with which they were nearly contemporary in

* *Quarterly Journ.. Geolog. Society*, London, 1869, p. 49.

† *Proceeds. Amer. Assoc. Adv. Sci.*, 1870, Vol. xix, p. 241.

‡ "Synopsis of the Families of Vertebrata," *American Naturalist*, Oct., 1889. *Syllabus of Lectures on Vertebrata Univ. of Pennsylvania*, July, 1891, p. 38.

time. It is doubtful whether the family of the Mesosauridæ on which the Proganosaurian order was founded by Baur, really belongs to this series, while the genus Procolophon Owen probably does. This genus has been regarded as the type of a group, the Procolophonina, by Seeley, and the genus Proterosaurus has been made the type of another group by the same author, under the name of Proterosauria. I have shown that the postorbital bar of the Pelycosauria (? Theriodonta) is different from that of the Anomodontia, and that the Cotylosauria (Pariasauria) is entirely distinct as an order. The Theromora as an order will then include the suborders, Placodonta, Proterosauria and Anomodonta, The problematical genera above named will all fall within the limits of the Proterosauria, as I have defined it under the name of Proganosauria.

EMBAPHIAS CIRCULOSUS, gen. et sp. nov.

*Char. gen.* Cervical vertebræ short, with the parapophysis and diapophysis distinct at the base and articulating freely with the centrum. Articular faces of the centra concave in the cervical and dorsal regions. Suture of neural arch with centrum, persistent.

The limbs of this genus are not certainly known. The three vertebræ on which it is established were found associated with a considerable number of the vertebræ of Elasmosaurus, and a number of bones of the arches and extremities. The proper location of the latter has not yet been made.

This is a short-necked genus, and need not be compared especially with Plesiosaurus, Elasmosaurus and Polycotylus. It differs from Uronautes, Orophosaurus and Trinacromerum in the distinctness of the basal parts of the dia- and parapophyses, and from the first two in the strong concavity of the vertebral centra. It approaches nearest in its vertebral characters to Pliosaurus, but here the dorsal vertebræ are amphiplatyan as in Plesiosaurus. I note here that the vertebral characters of Trinacromerum Cragin, as described by him,* agree with those of Orophosaurus.†

*Char. specif.* Cervical centrum a regular transverse wide oval, without lateral longitudinal angulation. Dia- and parapophysial facets compressed so as to be vertical, and occupying a line from near the level of the inferior face to the base of the neural arch, and fused together at their bases. The bases of the dia- and parapophyses (which are lost) were thus vertically compressed, presenting a character different from that of any Plesiosauroid known to me. On other cervicals than the single one preserved, this character may not be so pronounced, but it is not likely to have been entirely wanting on any of them. The outlines of the dorsal vertebral centra are circular, and the slightly concave sides are without angulation. The fossa for the neurapophysis is an anteroposterior oval, which does not extend over the entire length of the centrum. Arches lost, except the bases, which adhere within the fossæ. An epiphysis-like band of vertically lined surface, narrows the median longitudinally lined surface of

* *American Geologist*, 1888, p. 404; 1891, p. 171.

† *American Naturalist*, 1887, p. 564.

the middle portion of the surface of the centrum, especially at the middle line below, where it is thickened. A large foramen on each side of the middle line below, and a large one below the parapophysis in the cervical, and below the neurapophysis in the dorsal centra. Some smaller ones on the sides of the dorsals. Surfaces of the centra smooth. Neural canal narrow.

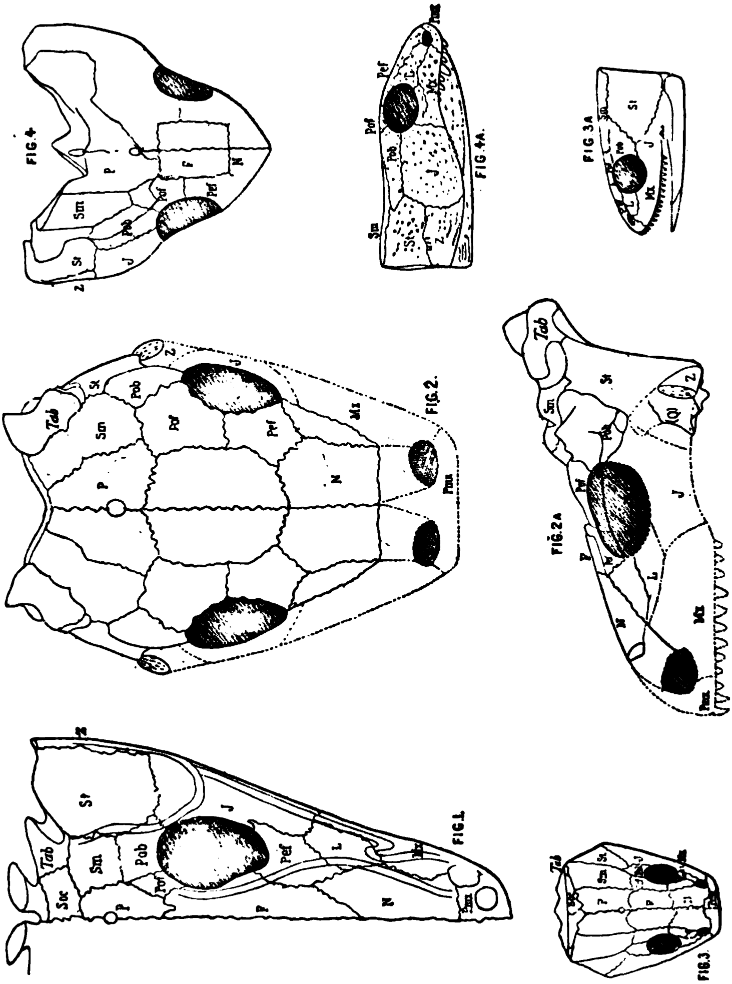
| *Measurements.* | | MM. |
|---|---|---|
| Diameters of cervical centrum | anteroposterior | 45 |
| | transverse | 85 |
| | vertical | 76 |
| Vertical diameter of common base of dia- and parapophysis | | 67 |
| Diameters of base of parapophysis | anteroposterior | 17 |
| | vertical | 36 |
| Diameters of a dorsal centrum | anteroposterior | 54 |
| | transverse | 99 |
| | vertical | 95 |
| Width of neural canal at base | | 19 |
| Depth of concavity of centrum | | 13 |

This is a species of large size, though not equal in dimensions to the known species of Elasmosaurus. It was found in the upper Cretaceous bed of the Pierre epoch, at the Big Bend of the Missouri river in South Dakota. It was presented to the Academy of Natural Sciences by Mr. John H. Charles, of Sioux City, together with the remains of Elasmosaurus below mentioned. I wish to express my sense of the obligation under which Mr. Charles has placed the Academy and myself by his liberality in this and other matters.

ELASMOSAURUS INTERMEDIUS, sp. nov.

Established on a series of nineteen vertebræ of the cervical and anterior dorsal regions of an individual from the Pierre formation of South Dakota.

The vertebral centra are the shortest known in the genus, approaching the Cimoliasaurus in proportions. The median and anterior cervicals display the compressed form characteristic of Elasmosaurus, although they are shorter than in the three known species of that genus. The posterior median cervical vertebræ are depressed, but the centra of the posterior members of that series are less depressed, and they increase in length less rapidly than they do in depth. They are shorter absolutely and relatively than in the *E. orientalis* Cope, to which this species is most nearly related. In the anterior dorsals the depth exceeds the length of the centrum, while in the *E. orientalis* the depth is about two-thirds the length. The cervicals exhibit an angle of the lateral surface about half way between the diapophysis and neurapophysis. The angle disappears on the anterior dorsals. The superior and inferior outlines of the articular faces are not emarginate or concave medially, which they are in the *E. orientalis.*




*Stegocephali and Cotylosauria.*

The lateral walls of the centra near to the articular faces are marked with strong rather sharp ridges, which are separated by grooves of several times their width.

*Measurements.*

| | | MM. |
|---|---|---|
| Diameters of an anterior cervical | anteroposterior | 55 |
| | transverse | 44 |
| | vertical | 45 |
| Diameters of a median cervical | anteroposterior | 76 |
| | transverse | 70 |
| | vertical | 65 |
| Diameters of a posterior cervical | anteroposterior | 78 |
| | transverse | 107 |
| | vertical | 88 |
| Diameters of an anterior dorsal | anteroposterior | 74 |
| | transverse | 96 |
| | vertical | 90 |

The specimen was found with that of the *Embaphias circulosus* at the Big Bend of the Missouri in South Dakota, and was presented to the museum of the Academy of Natural Sciences by Mr. John H. Charles, of Sioux City, Ia.

ELASMOSAURUS sp.

Prof. N. H. Winchell sent me for examination a portion of the vertebral column of a Plesiosauroid from the Niobrara Cretaceous of Dakota (exact locality not known), which consists of forty-three centra and portions of the arches and limbs. It is one of the shorter-necked forms of the genus, resembling the *E. intermedius* in the proportions of its cervical vertebræ. The dorsals are relatively larger, but they are all, with most of the cervicals, so distorted by pressure that it is impossible to characterize the species.

## EXPLANATION OF PLATE.

Permian and Triassic Cotylosauria and Stegocephali:

Fig. 1. *Mastodonsaurus giganteus* Jaeger; $\frac{1}{13}$ nat. size; from the Trias of Germany. From Fraas.

Fig. 2. *Chilonyx rapidens* Cope; $\frac{3}{13}$ nat. size; from the Permian of Texas.

Fig. 3. *Pariotichus megalops* Cope; nearly nat. size; from the Permian of Texas.

Fig. 4. *Pantylus cordatus* Cope; nearly half nat. size; from the Permian of Texas.

*Lettering.*

*Tab.*, Os tabulare; *Soc.*, Supraoccipital; *Sm.*, Supramastoid; *St.*, Supratemporal; *Z.*, Zygomatic (quadratojugal); *Pob.*, Postorbital; *Pof.*, Postfrontal; *P.*, Parietal; *F.*, Frontal; *Pef.*, Prefrontal; *J.*, Jugal; *Q.*, Quadrate; *L.*, Lachrymal; *Mx.*, Maxillary; N., Nasal; *Pmx.*, Premaxillary.

## *Forests of Pennsylvania.*

*By J. T. Rothrock, Botanist Member of the Pennsylvania Forestry Commission.*

*(Read before the American Philosophical Society, March 2, 1894.)*

Exact statistics as to the forest area are as yet not available for the State of Pennsylvania. It is true that we can speak with some certainty of the area of our State which is devoted to farming interests. Deducting this from the known area of the State would, however, still leave us very wide of an exact statement as to the area actually covered by a growth of wood which is now, or ever will be, productive forest land. There would remain unaccounted for the space covered by cities, towns and villages; by mines, where the surface is allowed to remain unutilized because the wealth below dwarfs its importance, and because the surroundings are not favorable to production of trees; and lastly there would remain the fact that an enormous percentage of the reputed woodland is now producing timber of the slowest growing and least valuable kinds of wood, if indeed it should be designated as wood at all. It will be, however, an approximate statement, based upon the reports of our assessors for the year 1892, to say that we have accounted for 16,359,387 acres of cleared land, and 9,159,826 acres of woodland. This will at least fairly represent farming land, and the area covered by woody growth of some kind, and may afford a basis for computation as to the condition of things which *should* exist. By the above statistics we may account for about 25,555,500 acres of farm and woodland. This, however, leaves from four to six millions of acres of our State area to be accounted for as coming neither under farming nor forest conditions at present. Nominally we have nearly 36 per cent. of our area in trees, if we accept our assessors' statements as a basis of calculation.

For convenience sake this paper will be divided thus:

I. The Kinds of Timber-producing Trees in Pennsylvania.
II. Most Important Timber-producing Areas in Pennsylvania.
III. Configuration of the State in Relation to Growth of Timber.
IV. Rates of Growth of Most Important Kinds of Timber.
V. Obstacles to the Growth of Timber.
 (*a*) Natural Obstacles.
 (*b*) Obstacles due to Human Agencies.
VI. Relation of the Commonwealth to Forest Restoration.
VII. Methods of Forest Restoration.

### I. The Kinds of Timber-producing Trees in Pennsylvania.

The list of such trees indigenous to our State, which are of sufficient size, or in sufficient abundance to be of commercial importance, numbers seventy-eight species and is as follows:

3 Magnolia glauca L................Sweet bay, or swamp laurel.
2 Magnolia acuminata L.............Cucumber tree.
3 Magnolia tripetala L................Umbrella tree.
1 Liriodendron tulipifera L...........Tulip poplar.
2 Tilia Americana L.................Basswood.
2 Tilia heterophylla Vent............White basswood.
3 Ilex opaca Ait.....................American holly.
3 Ilex monticola Gray...............Mountain holly.
3 Æsculus octandra Marshall.........Sweet buckeye.
3 Æsculus glabra Willd..............Ohio buckeye.
3 Acer Pennsylvanica L.............Striped maple.
1 Acer saccharinum Wang...........Sugar maple.
2 Acer dasycarpum Ehrh............White, or silver maple.
2 Acer rubrum L.....................Red, or swamp maple.
3 Negundo aceroides Mœnch.........Box elder.
3 Rhus typhina L....................Staghorn sumach.
1 Robinia pseudacacia L.............Locust.
3 Gymnocladus Canadensis Lam.....Kentucky coffee tree.
3 Gleditschia triacanthos L...........Honey-locust.
3 Prunus Americana Marshall.......Wild yellow, or red plum.
3 Prunus Alleghaniensis Porter.......Allegheny plum.
3 Prunus serotina Ehrh..............Wild black cherry.
3 Pyrus coronaria L.................Crab apple.
3 Pyrus Americana DC..............American mountain ash.
3 Cratægus coccinea L...............Scarlet haw, or whitethorn.
3 Cratægus punctata Jacq............Blackthorn, or pear haw.
3 Cratægus Crus-galli................Cockspur, or Newcastle thorn.
3 Liquidambar Styraciflua L........ Sweet-gum tree, or bilsted.
3 Cornus florida L...................Dogwood, or flowering dogwood.
3 Cornus alternifolia L., f............Alternate-leaved dogwood.
2 Nyssa sylvatica Marshall..........Sour-gum, tupelo, pepperidge.
3 Oxydendrum arboreum DC.........Sorrel-tree, sour-wood.
2 Diospyros Virginiana L............Persimmon.
1 Fraxinus Americana L.............White ash.
2 Fraxinus pubescens Lam...........Red ash.
2 Fraxinus viridis Michx., f..........Green ash.
2 Fraxinus sambucifolia Lam.........Black, hoop, ground, or water ash.
3 Chionanthus Virginica L...........Fringe tree.
2 Catalpa bignonioides Walt..........Catalpa, Indian bean, cigar tree.

This tree is not a native of Pennsylvania, but is becoming rapidly and generally naturalized, and is likely to be of considerable importance. For this reason I have included it in my list.

2 Sassafras officinale Nees............Sassafras.
2 Ulmus fulva Michx................Slippery elm, red elm.
1 Ulmus Americana L...............White elm, American elm.

2 Celtis occidentalis L...............Hackberry, nettle tree.
2 Morus rubra L.....................Red mulberry.
2 Platanus occidentalis L............Buttonwood, sycamore.
2 Juglans cinerea L..................Butternut, white walnut.
1 Juglans nigra L...................Black walnut.
1 Carya alba Nutt..................Shellbark, or shagbark hickory.
2 Carya sulcata Nutt.............. .Big shellbark, king nut.
1 Carya tomentosa Nutt.............White-heart hickory, mocker nut.
1 Carya porcina Nutt................Pig-nut, or broom hickory.
2 Carya amara Nutt........... .....Swamp hickory, or bitternut.
2 Betula lenta L.....................Cherry, sweet, or black birch.
2 Betula lutea Michx. f..............Yellow, or gray birch.
2 Betula populifolia Ait.............White birch.
2 Betula papyrifera Marshall.........Paper, or canoe birch.
2 Betula nigra L.....................Red, or river birch.
3 Ostrya Virginica Willd.............Hop-hornbeam, leverwood.
3 Carpinus Caroliniana Walter.......Hornbeam, blue, or water beach.
1 Quercus alba L....................White oak.
2 Quercus stellata Wang.............Post, or iron oak.
2 Quercus macrocarpa Michx.........Bur oak, overcup oak.
2 Quercus bicolor Willd..............Swamp white oak.
1 Quercus Prinus L..................Chestnut oak, rock chestnut oak.
1 Quercus Muhlenbergii Engelm.....Yellow oak, chestnut oak.
1 Quercus rubra L...................Red oak.
1 Quercus coccinea Wang............Scarlet oak.
1 Quercus coccinea var. tinctoria Gray.Black, or yellow-barked oak.
2 Quercus palustris Du Roi...........Swamp, or pin oak.
3 Quercus falcata Michx.............Spanish oak.
3 Quercus nigra L...................Black jack, or barren oak.
3 Quercus imbricaria Michx..........Laurel oak, shingle oak.
3 Quercus Phellos L.................Willow oak.
1 Castanea sativa Mill. var. Americana
Gray........................Chestnut.
3 Castanea pumila Mill..............Chinquapin.
2 Fagus ferruginea Ait...............Beech.

There appears to be no native willow of sufficient importance to merit a place in this list.

1 Pinus Strobus L...................White pine.
1 Pinus rigida Miller.................Pitch pine.

Under the pitch pine the Pennsylvania lumberman groups what he recognizes as yellow and jack pine.

2 Pinus pungens Michx., f...........Prickly pine, poverty pine, table mountain pine.
2 Pinus inops Ait....................Jersey, or scrub pine.

3 Pinus mitis Michx..................Short-leaved yellow pine, yellow pine.
2 Pinus resinosa Ait..................Norway pine, red pine.
2 Picea nigra Link....................Black spruce.
1 Tsuga Canadensis Carr.............Hemlock.
2 Abies balsamea Miller..............Balsam, balsam fir.
2 Larix Americana Michx ...........Hackmatack, larch, tamarack.
2 Thuya occidentalis L...............Arbor vitæ.

The above trees I have divided into a first, second and third class, and designated the class by a corresponding figure to the left of the name. Commercial importance and abundance are made the basis of this artificial classification: the only merit of which is that it will serve to impress certain leading facts.

The nomenclature adopted is that of Gray's *Manual of Botany*, which will remain the popular authority until superseded by a more modern book.

## II. Most Important Timber-producing Areas in Pennsylvania.

The words, "most important" timber-producing areas, are, of course, in one sense, relative, because they carry a twofold meaning, *i. e.*, important as to quantity produced, and important as to the uses made of each kind of wood. In one sense we might consider hemlock and white pine the most important for Pennsylvania; because the former is a characteristic tree of our State, and the latter one of immense commercial importance. We shall, however, use the words more especially in regard to the quantities produced on land which may be regarded as by nature better adapted to the growth of timber trees than to any other purpose.

This would naturally suggest the mountain areas of the Commonwealth. It must be remembered, however, that an exclusive consideration of these regions would practically exclude the soil on which our best white oak, black walnut, ash, tulip poplar and linden have grown. Furthermore, land now of more value for agricultural purposes than for any other uses might by some change in price of crops, or by other commercial perturbations, be ultimately found of greater value in production of some quick-growing kind of timber. This chance is quite within the limits of possibility in the case, for example, of the chestnut tree, if the fruit should ever become, as in Southern Europe, an important article of food and a stimulus be given to the production of choice varieties of the tree. Indeed it is by no means certain that we shall not very soon have an example in the increased demand for young chestnut as a source of supply for tannin.

Extending northeast from the southern border of the State through the central third is a region of varied topographical characters. Much of it is mountainous and rocky, and but for the possible discovery of mineral resources, and those already known, is of no value except for the growth of timber. The actual area of the land of this character is not yet

accurately determined, though it will probably aggregate not less than 5000 square miles. Once the timber is removed from such land, under present conditions it becomes not only an unproductive area to the State, but too frequently a nursery of floods during the time of melting snows and in periods of unusual rainfall. The Commonwealth has, therefore, a double inducement to restore it to its normal condition, either by direct care, or by such wise legislation as will enable the owners to do so.

What this legislation will, or, should be, depends very largely on the condition of the owners of this timber-producing area. For example, in the State of New York the mountain areas—Adirondacks and Catskills—are comparatively isolated. State possession there seems not only the probable, but the natural thing, when one considers that these same mountain regions are most important as water sheds for the eastern parts of that Commonwealth.

On the contrary, in this State the mountain areas are quite too large to encourage the idea that they ever will, or ever should, become the property of the State. In short, they will most likely remain in the hands of the small land holder, and the legislation intended for such areas must, from the nature of the case, be chiefly adapted to his needs.

Considering the counties of the State alphabetically, it appears that the cleared and the forest acreage of the Commonwealth is as follows:

*Table Showing what Percentage of the Entire Acreage of Each County is Timber Land.*

| Counties. | Cleared Land. | Timber Land. | Entire Acreage. | Per cent. | Classification. | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | % 25 | % 50 | % 75 | 100 |
| 1 Adams | 251,637 | 55,571 | 307,208 | 18 | 18 | | | |
| 2 Allegheny | 22,422 | | | | | | | |
| 3 Armstrong | 296,111 | 87,713 | 383,824 | 22.8 | 22.8 | | | |
| 4 Beaver | 196,616 | 59,214 | 255,830 | 23.1 | 23.1 | | | |
| 5 Bedford | 330,059 | 234,277 | 564,536 | 41.5 | | 41.5 | | |
| 6 Berks | 430,516 | 82,790 | 513,306 | 16 | 16 | | | |
| 7 Blair | 141,997 | 154,292 | 296,289 | 52 | | | 52 | |
| 8 Bradford | 468,350 | 204,131 | 672,481 | 30.3 | | 30.3 | | |
| 9 Bucks | 350,364 | 19,151 | 369,515 | 5.2 | 5.2 | | | |
| 10 Butler | 365,672 | 103,528 | 469,200 | 22 | 22 | | | |
| 11 Cambria | 322,394 | 73,507 | 395,901 | 18.5 | 18.5 | | | |
| 12 Cameron | 34,072 | 189,381 | 223,453 | 84.7 | | | | 84.7 |
| 13 Carbon | 82,646 | 109,744 | 192,390 | 57 | | | 57 | |
| 14 Centre | 189,580 | 124,107 | 313,687 | 39.5 | | 39.5 | | |
| 15 Chester | 389,306 | 52,474 | 441,780 | 11.2 | 11 2 | | | |
| 16 Clarion | 284,471 | 75,378 | 359,849 | 20.9 | 20.9 | | | |
| 17 Clearfield | 177,227 | 477,978 | 655,205 | 72 9 | | | 72 9 | |
| 18 Clinton | 148,957 | 405,881 | 554,838 | 73.1 | | | 73.1 | |
| 19 Columbia | 186,808 | 100,426 | 287,234 | 34.9 | | 34.9 | | |
| 20 Crawford | 425,103 | 180,600 | 605,703 | 29.8 | | 29.8 | | |
| 21 Cumberland | 231,161 | 40,057 | 271,218 | 14.7 | 14.7 | | | |
| 22 Dauphin | 213,768 | 102,972 | 316,740 | 32.5 | | 32.5 | | |

| Counties. | Cleared Land. | Timber Land. | Entire Acreage. | Per cent. | Classification. | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | % 25 | % 50 | % 75 | 100 |
| 23 Delaware . . . . . | 110,000 | 11,500 | 121,500 | 9.4 | 9.4 | | | |
| 24 Elk. . . . . . . . | 107,611 | 395,420 | 503,031 | 78.6 | | | | 78.6 |
| 25 Erie . . . . . . . | 403,722 | 47,264 | 450,986 | 10.4 | 10.4 | | | |
| 26 Fayette. . . . . . | 302,274 | 157,565 | 459,839 | 34.2 | | 34.2 | | |
| 27 Forest . . . . . . | 139,501 | 138,393 | 277,894 | 49 8 | | 49.8 | | |
| 28 Franklin . . . . . | 291,044 | 134,250 | 425,294 | 31.5 | | 31.5 | | |
| 29 Fulton . . . . . . | 114,172 | 182,636 | 296,808 | 61.4 | | | 61.4 | |
| 30 Greene . . . . . . | 341,607 | | | | | | | |
| 31 Huntingdon . . . | 259,416 | 229,390 | 488,806 | 46.9 | | 46.9 | | |
| 32 Indiana. . . . . . | 342,455 | 138,916 | 481,371 | 28.8 | | 28.8 | | |
| 33 Jefferson . . . . . | 200,565 | 187,985 | 388,550 | 48.3 | | 48.3 | | |
| 34 Juniata. . . . . . | 139,182 | 77,122 | 216,304 | 35.6 | | 35.6 | | |
| 35 Lackawanna . . . | 237,622 | 31,796 | 269,418 | 11.8 | 11 8 | | | |
| 36 Lancaster. . . . . | 512,169 | 57,148 | 569,317 | 10 | 10 | | | |
| 37 Lawrence . . . . | 186,793 | 19,221 | 206,014 | 9.3 | 9.3 | | | |
| 38 Lebanon . . . . . | 173,692 | 38,941 | 212,633 | 18 3 | 18.3 | | | |
| 39 Lehigh . . . . . . | 185,620 | 16,492 | 202,112 | 8.1 | 8.1 | | | |
| 40 Luzerne . . . . | 300,000 | 382,400 | 682,400 | 56 | | | 56 | |
| 41 Lycoming . . . . | 400,000 | 306,000 | 706,000 | 43.3 | | 43.3 | | |
| 42 McKean . . . . . | 387,088 | 230,371 | 617,459 | 37.3 | | 37.3 | | |
| 43 Mercer . . . . . . | 361,666 | 39,670 | 401,336 | 9.8 | 9.8 | | | |
| 44 Mifflin . . . . . . | 138,155 | 135,325 | 273,480 | 45.8 | | 45.8 | | |
| 45 Monroe . . . . . . | 152,100 | 170,810 | 322,910 | 52.8 | | | 52.8 | |
| 46 Montgomery . . . | 269,582 | 12,044 | 281,626 | 4.3 | 4.3 | | | |
| 47 Montour . . . . . | 59,811 | 15,314 | 75,125 | 20.4 | 20.4 | | | |
| 48 Northampton . . . | 189,591 | 21,448 | 211,039 | 10.2 | 10.2 | | | |
| 49 Northumberland . | 184,556 | 82,223 | 266,779 | 30.6 | | 30.6 | | |
| 50 Perry. . . . . . . | 150,817 | 149,658 | 300,475 | 49.8 | | 49.8 | | |
| 51 Philadelphia . . . | 80,000 | 3,000 | 83,000 | 3.6 | 3.6 | | | |
| 52 Pike . . . . . . . | 25,053 | 318,472 | 343,525 | 92.7 | | | | 92.7 |
| 53 Potter . . . . . . | 125,951 | 552,939 | 678,890 | 81.4 | | | | 81.4 |
| 54 Schuylkill. . . . . | 400,000 | 137,600 | 537,600 | 25.6 | | 25.6 | | |
| 55 Snyder . . . . . . | 132,303 | 66,322 | 198,625 | 33.4 | | 33.4 | | |
| 56 Somerset . . . . . | 291,081 | 278,223 | 569,304 | 48.8 | | 48.8 | | |
| 57 Sullivan . . . . . | 121,472 | 147,881 | 269,353 | 54.9 | | | 54.9 | |
| 58 Susquehanna . . . | 316,801 | 159,231 | 476,032 | 33.4 | | 33.4 | | |
| 59 Tioga. . . . . . . | 372,345 | 259,356 | 631,701 | 41 | | 41 | | |
| 60 Union. . . . . . . | 101,437 | 79,062 | 180,499 | 43.8 | | 43.8 | | |
| 61 Venango . . . . . | 188,658 | 166,096 | 354,754 | 46.8 | | 46.8 | | |
| 62 Warren. . . . . . | 250,314 | 174,671 | 424,985 | 41.1 | | 41.1 | | |
| 63 Washington. . . . | 422,637 | 64,119 | 486,756 | 13.1 | 13.1 | | | |
| 64 Wayne . . . . . . | 399,905 | 26,720 | 426,625 | 6.2 | 6.2 | | | |
| 65 Westmoreland . . | 420,832 | 148,680 | 569,512 | 26.1 | | 26.1 | | |
| 66 Wyoming. . . . . | 100,337 | 122,642 | 222,979 | 55 | | | 55 | |
| 67 York . . . . . . . | 430,213 | 112,338 | 542,551 | 20.7 | 20.7 | | | |

*Résumé.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2 | counties not fully reported. | | | | | | | | |
| 25 | " | have less than | | 25 | per cent. | of timber land. | | | |
| 27 | " | " | more | 25 | " | " | less than 50. | | |
| 9 | " | " | " " | 50 | " | " | " | " | 75. |
| 4 | " | " | " " | 75 | " | " | | | |

| | | |
|---|---|---|
| Cleared land | 16,359,387 | acres. |
| Timber " | 9,159,826 | " |
| Total | 25,519,213 | " |

25,519.) 9,159,826 (35.9% nearly,
or 9-25 nearly.

Thirty-five 9-10% of the land reported in timber.

From the above it will be seen that there are fifty-two counties whose area of timber land is less than fifty per cent. of that of the county. There are of these, seventeen whose area is less than twenty per cent. of the entire area of the county.

On the other hand, there are four counties where the area remaining in timber is at least seventy-five per cent. of the entire acreage of the county.

The assessors' reports do not represent the entire acreage of the counties as a rule. They are also faulty, or rather misleading, because much of what is there classified as timber land is not such in any present productive sense. Union and Mifflin counties are good illustrations. This remark is not designed to cast any discredit on their work. There are good reasons why they could make no nearer approach to an exact statement, and the wonder is that they have done so well. From four of the counties no exact report has been had. It is quite clear that of this thirty-five per cent. not less than one-fourth is producing nothing that should be called timber.

## III. Configuration of the State in Relation to the Growth of Timber.

In the present condition of affairs, in this Commonwealth, it is safe to assume that land which is too poor to yield remunerative crops had better be devoted to the growth of something else than the growth of cereals, or to put the proposition more broadly, agriculture on such ground does not pay. To this one may add another proposition which comes partly as a sequence of the first: *i. e.*, that land so steep as to be farmed at a disadvantage, unless it is specially adapted to grazing, tending to become impoverished by the washing away ot the elements of fertility, and requiring constant restorative measures, is not remunerative under ordinary agriculture and therefore should be restored to growth of timber. It is to be observed that these statements are made not as a basis for any State interference, but merely as suggestions for the individual land owner.

The most important timber trees of this State are white pine, hemlock,

white oak, rock oak, pitch pine, shellbark and pignut hickory, black walnut, locust and chestnut. Of these the white pine is a tree of wide geographical range, and of equally wide powers of adaptation to conditions of soil and climate. Originally it grew more or less commonly through the State from the northern to the southern boundary, and most abundantly along the central meridian. It is especially noteworthy that though its favorite locality was on the higher, poorer soils, where, when once cleared, the land had little agricultural value, that it still grew luxuriantly on some of the lower, richer lands. What the original rate of reproduction over most of its area was cannot now be answered with certainty. It is, however, safe to say that on the soil best adapted to its growth in the central part of Pennsylvania, one may expect to see a tree of this species grow in from fifty-five to sixty-five years to a diameter at two feet above the ground of from eighteen to twenty-two inches. Such timber is not mature. An inspection of the stump of one felled at this age will reveal the fact that the tree was then in the most productive period of its growth, and hence that it was poor policy to sacrifice it then.

The hemlock prefers the rocky sides of our mountain gorges, or a rocky hillside overlooking a stream. Occasionally it appears in a deep forest on a flat by a stream. It is very scarce along the southern border of the State except in the mountains proper, where it extends its range to the south.

If it were required to select a single tree which should be peculiarly representative of Pennsylvania the hemlock would probably most fully be so. Here to a greater extent than in any other State it has been an important tree in our lumbering interests, and no less important in the manufacture of leather. Here also its most reckless destruction has been witnessed; where miles of matured hemlock forest have been absolutely sacrificed for the bark alone. In this State also there are probably more miles suited to reproduction of hemlock than in any other Northern State. In some respects the hemlock is peculiar; for example, the nurseryman finds no great trouble in raising it, growing it into hedges or even into isolated trees. Yet the experience of our lumbermen and the few who have tried to restore it as a forest tree has not been encouraging. Of course there are reasons for the different results, mainly due to the fact that the forester works under conditions which are inimical to its growth and which, to a large extent, the nurseryman can avoid. Still the fact remains that the hemlock is among the slowest of our forest trees in its early growth, and when the shade under which it originally grew is destroyed the difficulties of its reproduction are immensely increased. It is, however, of the utmost importance to the Commonwealth that its restoration be attempted, first, because of its intrinsic value; second, because it grows and thrives on land which, but for it, would be almost valueless. The hemlock is, as a rule, a tree having but little tap root. Its roots spread out along or just beneath the surface of the soil. Yet as one of the biological marvels connected with this wonderful tree, it will often be

found attaining its most vigorous growth and size on a rocky hillside where there is almost no soil in sight. Of course it is clear that under such conditions it must have departed from its usual rule and sent its roots deeply down beneath the surface.

The white oak would probably come next in popular esteem. It is, however, fairly a question whether the rock oak is not of greater commercial importance to this State. The best white oak, as regards both strength and durability, contrary to the general opinion, comes from the rich alluvial lands. To the truth of this proposition both science and the most intelligent experience testify. Probably of all our important forest trees, no species is more readily grown than the white oak. Mere altitude (so far at least as our State is concerned) appears to be no obstacle to its growth. We find it at the level of tide and also at an elevation of two thousand feet and upwards. It will flourish along the mountain sides, then suddenly disappear as you reach the steeper, rocky slopes, where the rock oak by its abundance gives character to the forest. It can hardly be supposed that altitude alone has been the determining cause of its disappearance. The statement has already been made that white oak from higher, poorer soil was of inferior quality, and this may indicate such a lack of physical vigor as makes it unable to cope with the hardier rock oak and locust which abound on such situations. Some of the most thrifty young white oak groves I have found in this State have been between the altitudes of one thousand and seventeen hundred feet above the sea level. In such situations the soil, however, was loamy, and with so few rocks that, once cleared, it might well enough have served for agricultural purposes. On the mountain slopes, just at the foot of the steeper incline, where there is an accumulation of loam washed from the heights above, the growth of white oak is often the most vigorous. This fact seems to obtain in our State without regard to altitude, and points again to the conclusion that for the most successful growth of this species, a fertile, comminuted soil is of the first importance.

Rock oak, locust and chestnut form, in one sense, a group by themselves—that is they agree markedly in certain peculiarities of habit, being always found associated under certain conditions, and yet on the other hand each able to thrive under conditions which would be inimical to the best development of the other. For example, they all may be expected to grow in association along those mountain slopes where the Medina and Oneida sandstones appear; neither altitude nor the rocky masses seem to prevent their growth. Yet the limestone almost certainly exercises a limiting influence on the chestnut and possibly on the rock oak, while the locust often becomes a very large tree on limestone soil.

The pitch pine may be regarded as a tree of pliant constitution. Its most constant home is on the higher mountain areas of the State. It is, however, to be observed that the reason why it now appears most frequently there is simply because it has been largely extirpated from all

other sites. The mountain tops are its remaining strongholds. It is, however, also found growing in the sands of the seashore.

The hickories (shellbark and pignut) are trees of lower ground. The former seldom leaves the alluvial flats, and though the latter is often found on the higher grounds, it seldom reaches the mountain top. Were it not for the fact that Eastern North America is the only natural home of our most valuable hickories it would hardly be worth while, or fair, to place them among our most important trees. In fact their approaching scarcity in connection with their easy reproduction is their strongest claim to notice here. As a rule all the species of hickory demand a good soil—even though it may be on a hilly surface.

Black walnut has been of importance. It is practically exhausted now. During the season's travel I have seen almost none remaining that was fully matured.

The white walnut grows along streams even high up on the mountain side, but the black walnut seldom is found in a thriving condition among the rocks of the higher, steeper slopes. This tree (black walnut) appears to grow equally well on limestone soils and on alluvial flats. Though it seems to be as averse to the Oneida and Medina sandstone regions as the rock oak, chestnut and locust are partial to them.

## IV. Rates of Growth of Most Important Kinds of Timber.

The rates of reproduction and of growth in this country are both a surprise to a foreign forester. It is with the latter of these that we are chiefly concerned, for the mere reproduction of seedlings is, as a rule, so vastly in excess of what the ground can support that the question is narrowed down to rate of growth of the surviving trees.

It is fair to lay down the general propositions that growth in height of our more important species is mainly a question of environment, and that wood production attains its yearly maximum about the close of the second third of the average life of the tree.

The first of these important propositions bears probably less upon the weight of the adult tree than it does on the character of the main trunk and on the spreading of the more important branches; in other words, that the towering white pine, white oak, or tulip poplar which has grown up in a dense forest has probably about the same quantity of wood in it that the more spreading specimens of the same species would have when grown in more open ground.

To illustrate the importance of the second proposition, that the maximum wood production is about the close of the second third of the tree's life, let us for a moment consider the relative values of one-fourth of an inch of new wood around a stem whose diameter is six inches and one whose diameter is twenty-four inches, the proportion would be as eighteen is to seventy-two, or to reduce it to a decimal, the annual wood production of the smaller stem would be but twenty-five per cent. of the larger.

There is no species of tree whose rate of growth is independent of environment. In Germany fifty cubic feet of wood is reckoned a large annual production for an acre. In this country there are abundant facts to prove that from one hundred to one hundred and twenty-five cubic feet is not unusual for the same time and on a like area.

To bring the question to a more practical presentation, it is fair to say that the average annual growth of a white oak on our mountain sides is between one-sixteenth of an inch and one-eighth. A tree of the same species growing on the alluvial flats of the lower Delaware or Susquehanna would show an average year's growth of from one-eighth to one-fourth of an inch. The rock chestnut oak on the rocky side of a mountain will probably require from eighty to one hundred years in Pennsylvania to attain a diameter of one foot. The same species of tree I have known to reach the same size in forty-five years on better soil. Our common black oak illustrates the same principle in the lifetime of one and the same tree. Thus there are specimens in Centre county which grew with the average rapidity of the species for, say, forty years and then suddenly ceased to grow and began to die at the top because their roots had reached a bed of limestone just beneath the surface of the soil. So, too, I have in mind specimens of white and scarlet oak, which, under favorable conditions, kept pace in growth with sugar and silver maples near which they were planted.

A second growth, sprouting from vigorous stumps, develops much more rapidly than the original growth where the roots were smaller in proportion to the trunk. This explains the peculiar strength and value for certain mechanical purposes of the second-growth white oak in the rich lands of Indiana and Illinois. It is simply an illustration of the statement already made that the larger year's growth made a better lumber than the smaller (in the same species).

As a rule, we may say that a century will be required to mature white pine, hemlock and the hickories. The oaks will require half as much longer time. Chestnut may be regarded as making a fair body of mature wood in seventy-five years.

## V. Obstacles to the Growth of Timber.

### (a) *Natural Obstacles.*

These have been in part anticipated by the statements already made. Among these poverty of soil may be regarded as first in importance. This, however, is connected with an induced poverty due to removal of an earlier forest growth whereby on the steeper slopes the soil is washed away more rapidly than it is renewed. Indeed, one philosophical observer has stated that if the forests were removed from our Pennsylvania mountains and they allowed, for any considerable time, to remain without trees, that reforestation would be practically impossible. Whether this statement is, or is not, true as a scientific principle, it may at least be

allowed that the difficulties of producing a new forest growth would be infinitely increased. Fortunately we are, to a very great extent, exempt thus far from the fungal and insect foes which have produced such serious havoc in Central Europe. It is, however, within the limits of probability that there may come a time when this immunity will cease. For example, in the Adirondacks certain of the cone-bearing trees have to a limited extent been injured by the fungus which produces the clustered branches known as "witches' brooms;" and in Fulton county of this State, one or more small species of beetles have within the last three years killed considerable bodies of pitch pine by burrowing beneath the bark and destroying the young cambium layer on which the life of the tree depends. It is estimated that in West Virginia these same insects have destroyed $1,000,000 worth of timber in the last four years.* It is interesting to note that an insect antagonistic to these beetles has been found in considerable numbers on the infested trees. To what extent they may succeed in holding the beetle in check remains to be seen. The most promising plan of treatment would seem to be to cut and burn every infested tree. The fact that thus far the insect invasion has been slow and affecting only isolated clumps indicates the possibility of successfully heading it off if dealt with promptly.

The natural tendency in this State is towards a spontaneous reproduction of forests. This shows that the obstacles are neither numerous, nor grave in character.

### (b) *Obstacles Due to Human Agencies.*

The chief obstacle here is fire—operating now in one way and now in another—and caused by design, often with malicious intent, or by accident on the part of an individual, or by a passing train.

Fire acts directly and indirectly to prevent the growth of timber.

Thus directly it kills the seeds, saplings, and often mature trees, such as the hemlock and the white pine.

The most destructive fires are those which follow close upon the operations of the lumberman. The débris left by him invokes the flame and furnishes the requisite fuel for it, when once created. One severe conflagration, especially if on a steep hillside, may not only blight the promise of a coming crop of trees, but may lead to the destruction of the soil to such an extent that almost no plant life can flourish. And year by year the little remaining soil is carried away by the descending rain until restoration of forest growth seems almost impossible. Instances of this condi-

* This note from Mr. Charles W. Johnson explains itself:

"There are several species of beetles destructive to the pines of West Virginia. The principal ones are *Dendroctonus frontalis* or 'The Destructive Pine Bark Beetle.' *Tomicus calligraphus*, and *Tomicus cacographus*, the latter is the one we found in Fulton county. The Clerus imported from Europe is the *Clerus formicarius*, 'European Bark Beetle Destroyer.' The one we found in Fulton county is closely allied and is known as *Thanasimus dubius*."

tion occur near the head of Long Run, in Clinton county, and in portions of the Beech Creek region in Centre and Clinton counties.

Fires are frequently created to destroy the young timber and to encourage the growth of grass for summer pasturage for cattle. The writer saw one such instance during the past season where a most valuable body of young white pine was destroyed, and it seemed morally certain that it was by a fire started in the interest of a score of vagrant cattle. Of course the remedy for such a state of affairs might be prompt and sure. Confiscation of such cattle, by due form of law, when found without permission on land of other parties would end once for all this burning. There can be no doubt that a considerable percentage of forest fires is the result of absolute maliciousness. Luzerne county of this State, but a few years ago, furnished numerous examples of what were doubtless to be attributed to this cause. The cure here is by no means so simple as at first appears. The remedy which seems most popular at present, not only in this, but other States, *i. e.*, authorizing supervisors, or other officers, to call out men to suppress forest fires and paying them for their work, has been found by actual trial in several counties of this State to be an inducement to create fires on unseated lands. It is a humiliating admission, but it is clear that those and other regions of our own Commonwealth are not sufficiently law-abiding, or observant of ethical principles, to make this method practicable. The enactment of rigid and severe penal statutes is a matter of doubtful value, unless accompanied by a costly machinery to ferret out and bring offenders to justice. Opening of fire lanes through the timber lands raises the question by whom shall it be done—at individual or at State expense? The same may be said of keeping them open. There can be no doubt that well-kept fire lanes do render suppression of such fires more easy, even if they do not interpose a certain barrier to their spread. It will probably become more and more clear that timber protection and production in this State will be effective and common just in proportion as it is made to the interest of the individual citizen to guard and plant trees. Here we come back to the most general of all principles under a popular government, that laws are strong and effective only when backed by public sentiment, and this may only be surely attained by an appeal to individual interests. This brings me to

### VI. Relation of the Commonwealth to Forest Restoration.

The first duty of government is either to perpetuate itself or to lead up to some higher, better form of government. On this hangs not only the safety of vested rights and the safety of capital, but the strongest incentives to individual thrift, industry, economy and rectitude are found in the idea that property acquired may be transmitted under protection of a stable government. There is no crime more unpardonable in the individual than the treason which strikes at the safety of the government. Is the act by which the State endangers its own prosperity and perpetuity

any less heinous? This reduced to its simplest terms is the issue now before the Commonwealth. Already after but two hundred and fifty-six years of civilized occupancy, Pennsylvania is called upon to interfere in order to restore to a productive condition, and to protect against extravagant use, about one-eighth of her area. Failure to act promptly now, and wisely, will entail on the coming generation loss of resource, individual suffering and increase of taxation to meet the demands of pauperism. These propositions seem so clear in the light of present resources and prospective population that it is a waste of words to discuss them.

There are, at least, three thousand square miles in this State to-day whose only possible function is the production of timber. There is, at least, an equal area of land now cleared, impoverished and becoming poorer each year, on which cultivation has been attempted, and proven hopelessly unremunerative, which should be covered again by a forest growth. No other proposition promises anything. Unless these six thousand square miles are kept in a productive condition they will be an absolute loss to the State and a continued menace to much of the productive farming land.

The problem is one of great magnitude. Two and only two lines of public policy are possible. The first one is for the State to assume control of such areas. The second is for the individual to be encouraged to make these areas productive under the stimulus of State direction and State aid. Which shall it be?

Where an area is distinctly isolated, and as yet in an unimproved condition in great part, on general principles it might be wiser for the State to assume direct and absolute control of it, because a far-reaching policy could be inaugurated which would look to the largest results ultimately. The necessity for such action would be more and more apparent if it could be shown that it was directly in the interest of the Commonwealth that the State should be the possessor of the land.

The State of New York undoubtedly is in that position to-day. The wisdom of her acquiring an absolute right to the Adirondack region by just and legal extinguishment of all individual titles, will depend upon no other condition than what use she makes of the land.

The State of Pennsylvania is not so fortunately situated. Her natural timber areas extend clear across from the northern to the southern border and almost bisect her territory. Important railway lines run through her belt of natural timber lands. Large rivers traverse them and thriving farms, villages and towns occupy the choicer parts of these areas, which as a whole may be designated as almost exclusively natural woodlands. Clearly the State could acquire no righteous title, nor could she, even if ownership were possible, administer an estate so broken and disconnected in an economical manner.

The remaining alternative is to recognize the fact that protection and utilization of these regions is of the first importance to the Commonwealth and to make it the interest of the citizen to serve the State. To this

proposition it is thought no one will object. But at present the State and the individual are absolutely at cross purposes so far as the timber lands are concerned. The township demands taxes for a protection which is not accorded; for improvements which it does not make and for profits which the owner does not receive. The facts are at hand to show that in certain portions of the State, timber land, which has yielded the owners nothing for thirty years, has in that period paid more in the way of taxes than the land could be sold for to-day. Is it strange that to save themselves, the owners of such lands should remove the timber and realize what they can, then abandon them rather than pay the taxes? This same timber would be worth much more to the owner if allowed to stand. The township which drives the man to remove this timber, then to abandon the land, loses at once taxes for present use, and resources of future value. It requires no argument to prove that this is a false policy.

We will briefly consider the results of a removal of taxes from timber land.

In the first place it would confer new value on these lands. Owners would, instead of wholly abandoning them, at least retain them. Retaining them, even uncared for, there would something of value grow upon them. Here and there a tree, often a young growth of forest trees; and what was of no value would come now to have a positive value, however small. The owner would have an interest, and what applies to the individual owner would apply to the community, and the man who by accident or by design fired land which was producing something and costing nothing would soon be a marked person. Public sentiment instead of looking almost with indifference on woodland fires would become actively interested in their suppression. Fire laws would have, what they do not now have, support; and the law which hitherto was a dead letter would become a living, real thing. So much gained as timber was becoming scarcer, the next inevitable step would be to increase the quantity of timber produced, to improve its quality and to diminish, so far as possible, the time required to mature it, as well also as to make the maturing forest pay for its own maintenance.

Here we have at once the germ of a forestry system. It would have the further advantage of being a system developed in harmony with our own environment. It is probable that in a quarter of a century we should be further on towards success than if we tried to adopt and adapt a foreign system to the conditions of a popular government.

Not only would the steeper, rocky hillsides respond productively to this new policy, but at once another element would enter the problem. Lands hitherto taxed as farm lands, but which were unremunerative, under cultivation would be planted in trees. And from being costly unproductive lands, become productive lands entailing no cost. The barren hillsides of this generation would have their virgin fertility partly restored and by the time they were required to produce crops for the larger population half a century hence would be in condition to do so. Then, when

the average farms have become reduced in size and a better system of agriculture inaugurated, we might hope they would be prevented, even if cleared, from relapsing into the unproductive condition in which they are found now. Probably by that time timber growing as a legitimate branch of agriculture would be established among us, and they would be found to pay enough to warrant keeping them in timber.

There are, however, two sides to this question. The Constitution of this State reads thus: "*Art. iii, Sec. 7.* The General Assembly shall not pass any local or special law exempting property from taxation."

It furthermore, *Art. ix, Sec. 1,* expressly declares "that all taxes shall be uniform upon the same class of subjects within the territorial limits of the authority levying the tax, and shall be levied and collected under general laws: but the General Assembly may by general laws exempt from taxation public property used for public purposes, actual places of religious worship, places of burial not used or held for private or corporate profit, and institutions of purely public charity.

"*Sec. 2.* All laws exempting property from taxation, other than the property enumerated, shall be void."

It will be seen from this that as timber lands are not in the favored classes their exemption from taxation was clearly forbidden.

The Constitution, however, distinctly recognizes the constitutionality of classification in persons and things to be taxed. *Art. ix, Sec. 1,* already quoted, expressly declares for it in the phrase "all taxes shall be uniform upon the same class of subjects."

It may be an open question whether or not it may be possible to claim exemption from taxes for timber lands on the ground that as they collected water from the State at large, as they aided in retaining the fertility of the soil on land other than that of the forest owner, they were in fact and deed "objects of purely public charity, or lands used for public purposes;" until the owner derived a revenue from them by the removal and sale of wood. It is, however, clearly within the power of the General Assembly to place them in a class by themselves under a specified minimum rate of taxation, because they are under different conditions of production and are wholly different from any other lands, and for the good of the Commonwealth require legislation different in character from any other lands. "Laws enacted in pursuance of such classification and for such purposes are, properly speaking, neither local nor special." It is equally clear that if tax were collected from such lands classified as a separate class it would be under a general law, which specified no individual, but dealt with a whole class of persons, all of whom were similarly conditioned.

Then again, even if tax were removed, or greatly reduced, on timber lands the whole problem would not be solved, because this would deprive many portions of the State, where an excess of timber over cleared land remains, of the funds required for current expenses. This difficulty is a serious one, and unless the deficit be made good, would be an absolutely

prohibitory objection to total or partial exemption of timber lands from taxation.

Let us consider this problem from another point. The water which turns our factory wheels and which is used by our larger towns and cities; whence does it come? As a rule, from forest-covered hillsides in remoter parts of the State. The mills, towns and cities seldom pay anything for it until it reaches their seats. The men who own the land pay the taxes and receive actually less from it than those who pay nothing for it. Put the proposition in its baldest form: The City of Philadelphia pays nothing for an element which is essential to its life and without which it could not endure a day until it reaches the city limits. Another portion of the community is taxed that we may receive our water free. Is this fair? The comparisons between air and water supply are not parallel. No one is taxed for air, we simply ask that these cases be made parallel by taxing no one for production of water. It is not too much then to say that the State at large is the beneficiary of the woodlands. Nor is it too much to ask that legislation be granted by which such counties of the State as endure a hardship by removal of taxes from their timber lands should be relieved by the State to the extent of their financial loss from this cause.

When timber comes to be removed it ceases to be a purely public benefit. It enters the domain of individual or corporate trade and should be taxed accordingly.

It is becoming more and more clear that officials are required whose duty it shall be to direct suppression of fires, and to ferret out offenders. The law should be imperative that every magistrate in the Commonwealth should report through proper channels at each session of Court all he knows of forest fires since previous session. It should be made a specific duty, to any evasion of which a penalty in some form should be attached. The State already allows annually a premium on trees planted thus: For 1200 to the acre during the first ten years ninety per centum of the tax paid on the same ground, providing said premium shall not exceed the sum of forty-five cents per acre. For the second period of ten years the premium is eighty per centum, providing that the premium shall not exceed the sum of forty cents per acre.

For a third and final period of ten years the premium shall be fifty per centum, providing that the premium so paid shall not exceed the sum of twenty-five cents per acre.

During and after the second period of ten years, the land owner may thin out his trees to not less than 600 per acre "so long as no portion of the said land shall be absolutely cleared of the said trees."

Nurserymen or other tree salesmen are not included in the benefits of this act.

Timber land which has been cleared may receive the same premium as above indicated, providing that notice has been given within one year from date of clearing of the owner's intention to maintain said land in

timber; the number of trees per acre required is the same, and, on the other hand, the privilege of thinning is the same as to time and number.

It is quite remarkable that so few of those who might have taken advantage of this law have been aware of its place on the statute book. The Commissioners of Schuylkill county have, however, paid to the Girard estate money due under the provisions of this act. The precedent is therefore established, and others may be expected to avail themselves of the benefits offered.

It will be seen, however, that liberal as these premiums are, they fail at the very period when there begins to be a temptation to cut, and when the average tree is in the state of its greatest productiveness, so far as the growth of wood is concerned. The woodland owner may keep his domain constantly in condition to earn the government premium; but he will produce no thoroughly good-matured wood if he is encouraged to cut it at thirty years of age.

These bounties mark an important advance in public sentiment on the forestry problem; but they fall far short of the full measure of usefulness one might expect from a complete remission of taxes, when such remission is based on an appreciation of the fact that public rather than private interest is most subserved by it.

It is clear that the question of an extensive State Forest Reservation is one which cannot be much longer postponed. That this is demanded not less in the interest of a pure, abundant water supply than it is by the ordinary interests of forestry is no less clear; and it almost follows as a matter of course that such reservation should be located on the water shed which supplies the largest quantity of pure water to the largest population. In this view of the matter, the spot where such reservation should be is plainly indicated by the topography of the State. It should be noted further that this reservation might be made equally available as a public sanitarium. It cannot be too strongly or too often noted that it is a measure of wise statesmanship, to provide an outing ground where those who are physically below par may by a sojourn in the open air of a wholesome region find renewed strength for the duties of life. This is suggested not on any basis of philanthropy or sentiment, but simply because it promises to reduce the number of those who otherwise might become charges on the Commonwealth.

## VII. Methods of Forest Restoration.

This division might come more properly in a treatise on practical forestry. Still it may be proper to make certain general statements here on the subject. So far as known, there are at present within the limits of the State but two areas which might with any degree of propriety be designated as illustrating forestry practice. Both of these are managed as a portion of the City Trusts, and are located one in Schuylkill and the other in Centre county.

Forest restoration in this Commonwealth should be mainly confined to two classes of ground—first, that which is fit for nothing else and otherwise would be unproductive, and second, that which is worn out by unproductive agriculture, and which would be more promptly and cheaply restored to virgin fertility by a return to primitive conditions. It is probably a safe estimate, as already indicated, that there are not less than six thousand square miles of territory which belong to one or the other of these classes; or to put the statement in another way, about one-eighth of the area of the State.

It is well to urge, that for the present and the immediate future, public or private forest operations of a restorative character should be confined mainly to such native forest trees as make the most certain and speedy growth. This would not necessarily exclude such trees as the oaks, for under favorable conditions these may be classed as rapid growers when compared with related trees elsewhere.

The most promising of the native trees would be white pine, chestnut, locust, black walnut; and on rich soil, shellbark, hickory and white oak. Hemlock culture will eventually become a necessity to the Commonwealth, but owing to its slow growth and its uncertain success had better not at present be urged. White oak is a tree of wide growth and therefore not so immediately in danger of becoming below our actual wants in quantity. Chestnut grows freely over a wide range of conditions; in other words, its natural tendency is to take care of itself. These facts make white pine the one tree whose immediate culture is most promising and most needed. How shall its restoration be most successfully undertaken? There are two methods, which we may properly designate as the nursery method and the method in final position. The former is probably not soon likely to become popular. Hence the latter method is the one most certain to lead to successful results in this country. The young trees ot this species are sensitive, as most cone-bearing trees are, to excess of sunlight. It should be started under the shadow of an existing open forest cover which is soon to be removed. To meet this condition, white pine seed should be sown, when possible on a northern exposure, in poor, or at least, in rather poor soil. The mature cones may be gathered in the autumn, kept in a cool dry place until spring, when many of the winged seeds will be found to have escaped from the cones. The remainder may be obtained by shaking or breaking the cones. Early in the spring, the sooner after the frost comes out of the ground the better, the leaves of the open woods should be lightly raked from the soil, in spots, so as to give the seeds a chance to come in contact with the soil, or at least with the damp leaves. Then cover the seeds lightly with a rake. This is rendered necessary by the fact that though the seeds of the white pine are well enough adapted to dispersion, they are not so well suited to self-planting, and many must fail of growth because they do not come in contact with a suitable substratum. When the young pines are three or four

years old the sheltering forest will have done its work and may be removed at any time.

It should be remembered that the cone-bearing trees are social in character and hence do better in dense groves. In fact, one may also say dense planting is an essential condition upon which rests the production of the best pine timber. It is probable enough that starting white pine in nurseries will some day come to be here, as elsewhere, the more common method, but it involves too much labor and care to recommend it at this stage of the Forestry Idea in the United States, or certainly, at least, in Pennsylvania.

Black walnut will always have a special value, and to make the idea more clear, it should be added that this value will depend on the character of the individual log. There are in this State thousands of acres of fertile river bottoms where agriculture has been practically abandoned because of the frequently recurring freshets, on which the black walnut would not only grow rapidly, but where it might be depended upon to produce a good quality of lumber. This tree does not, at first, grow rapidly on a soil of stiff limestone clay.

There is no surer way of starting the black walnut than to allow the fruit to remain out over winter under a slight cover of leaves. When spring comes it will probably be found that the frost has opened the fruit so that a prompt start that spring may be expected. As the black walnut does not bear transplanting well, it is better that the nuts should be planted where they are to remain.

All that has been said of the method of starting the black walnut applies to the shellbark and hickory as well.

The white oak is worthy of a moment's consideration. It grows with great certainty from good acorns, and may be planted in drills as soon as collected. If one thinks it really worth while to have his trees in the best condition for a vigorous start when finally transplanted, it is a good policy to lift and replant the young oaks at least twice before they are placed in permanent position. Good soil should be insisted upon as a cardinal point in white oak planting. If poor soil is to be occupied by oaks let the planting be of rock oak, providing the soil is well drained. All that has been said as to starting the white oak applies as well to starting the rock oak. The same may be said of the chestnut.

Our common locust tree, it is not generally remembered, is a native of the mountain sides of this State. This fact should suggest the extreme value it possesses in reclothing those steep, poor regions with a timber whose value will always be appreciated. It has the further fact in its favor, once fairly started, it resists better than almost any other species of our trees, the periodical scorchings it receives from the spring and autumn fires.

Further consideration of this topic from the practical standpoint would be out of place here.

# *Association: The Dominating Need of Man and the Keynote of Social Science.*

*By Henry Carey Baird.*

*(Read before the American Philosophical Society, March 16, 1894.)*

Never before to-day, in the history of the human race, has there been so earnest or so widely extended an examination of economic problems. At this very hour the philosophers of the orthodox political economy and their philosophy are on trial before Christendom ; and the issue is not : Is the philosophy true or is it false ? But rather : Is it or is it not so false and pernicious that when applied to human society that society is wholly unable to stand the strain, and is constantly, as a result, in danger of wreck ?

Social Science is fast emerging from that place wherein it has long been the plaything of school-men, who acknowledge themselves as being the teachers of "a science based on assumptions." Soon these teachers will be classed as mere metaphysicians, whose disquisitions can lead to no beneficent practical end, and their learned treatises will finally be consigned to that great lumber-room of the centuries which holds the larger part of the literature of the world, the forgotten, because useless books. Empires, kingdoms, republics, even society itself trembles in the balance, and these philosophers of "assumptions" have held the leading role in the terrible drama which places all of these human institutions in peril.

Therefore, does it seem fitting that so venerable and so renowned an institution as the American Philosophical Society should give some heed to the consideration of these vital problems. Hence do I ask your attention to

Association : The Dominating Need of Man and the Keynote of Social Science.

## Of Social Science.

In science the most important preliminary work is that of definitions, in order that the exact meanings of words may be distinctly understood, and when so understood, that those words shall always be used with the same significance. Social Science treats of man in his efforts for the maintenance and improvement of his condition, and as defined by the Master, Carey, is "The science of the laws which govern man in his efforts to secure for himself the highest individuality and the greatest power of association with his fellow-men." This definition is not only broad and comprehensive, but it points unmistakably to the true direction in which we must look for the investigation and solution of each and every principle in social science It uncovers and lays bare the very tap-root of the science itself.

### The Fundamental Principle.

From this definition it is but one step to the fundamental principle and this principle as enunciated, also by the Master, is as follows :

"Man, the molecule of society, is the subject of social science. In common with all other animals he requires to eat, drink and sleep, but his greatest need is that of *association* with his fellow-men. Born the weakest and most dependent of animals, he requires the largest care in infancy, and must be clothed by others, whereas to birds and beasts clothing is supplied by nature. Capable of acquiring the highest degree of knowledge, he appears in the world destitute even of that instinct which teaches the bee and the spider, the bird and the beaver, to construct their habitations, and to supply themselves with food. Dependent upon the experience of himself and others for all his knowledge, he requires language to enable him either to record the results of his own observations, or to profit by those of others ; and of language there can be none without association. Created in the image of his Maker, he should participate in His intelligence ; but it is only by means of ideas that he can avail himself of the faculties with which he has been endowed, and without language there can be no ideas—no power of thought. Without language, therefore, he must remain in ignorance of the existence of powers granted to him in lieu of the strength of the ox and the horse, the speed of the hare, and the sagacity of the elephant, and must remain below the level of the brute creation. To have language there must be association and combination of men with their fellow-men, and it is on this condition only that man can be man ; on this alone that we can conceive of the being to which we attach the idea of man."*

### All Social Science must Start from the Law of Association.

All true social science must of necessity start from this point. It can start from none other ; and any system which attempts to ignore this fundamental principle, as such, is false in its inception, and must of necessity be false throughout. There is no escape from this dilemma. The all-controlling condition which governs man in this world is that which obliges him to associate and combine with his fellow-men. Literally from the cradle to the grave, it controls his destiny and is at the bottom of all of the motives which, throughout his career, impel him to action. He is thus insufficient unto himself, and the higher his civilization the greater become his wants, and, therefore, the greater his dependence on his fellow-men and the more rigid and unyielding over his daily, his hourly life, the domination of the law. All social science is concerned about it ; and without it there would be no social science, no political economy, no wealth, no poverty, no money, no banks, no interest, no credit, no landlords, no tenants, no states, no cities, no towns, no villages, no governments, no taxes, no emperors, kings or presidents, no armies, no navies, no generals, no admirals, no steamships, no railroads, no

* Carey, *Principles of Social Science*, Vol. 1, p. 41.

mails, no post-office, no corporations, no shops, no trade, no commerce, no colleges, no schools, no poets, no historians, no history, no literature, no science, no philosophy, no language, no professors, no doctors, no lawyers, no laws, no society; but each and every man and woman would be a law and a power unto himself or herself; and so would every child, from the moment of its birth to the hour of its death. Indeed, the entire life of each and every human being would be different from what it now is, and no one would have any occupation whatever, except that of looking after his or her necessities. Thus, would each and every one of these human vegetables live, grow, and flourish like any other vegetable independent of his fellow-vegetables. In fact, the human animal of many of the economic philosophers partakes more of the nature of the vegetable than of that of the human being known as *man*, because this philosopher has ignored and dropped out of his system the very quality which most characterizes and controls man and which most separates him from the lower forms of life, both animal and vegetable.

### Wealth and Poverty, What are They?

What then is it that men struggle for, and worry about, live, wear out, and die to obtain, and retain under the name of individual wealth? It is simply the power to associate with, to command the services, the commodities and the ideas of the largest body of men. What then is individual poverty? The absence of the power readily to command these services, commodities and ideas. Thus, whether he be prince, millionaire, or pauper, man perishes of cold, of heat, of hunger, of thirst, of want, unless he can bring himself into association with his fellow-men. To sum up, the life of man is but a series, a net-work, a complication of acts of association, to cease the performance of which acts is, of necessity, to cease to live.

### Diversity.

The question now arises, How is this power of association to be developed? Primarily, by means of a diversity in the capabilities, employments, productions, and wants among the people constituting society; to the end that there shall there exist the greatest number and the most powerful societary positives and negatives attainable or conceivable. To accomplish this the consumer must be brought to the side of the producer, the plough, the loom, and the anvil, the farm, the factory, and the workshop existing and growing up alongside of and in harmonious relations each to the others, giving and receiving, blessing and being blessed. Thus, and thus only, can labor power, the most perishable of all commodities, be utilized on the instant of its production, and crystallized into work, the basis of all wealth, individual and national. No foreign commodity is therefore cheap or desirable to a people, no matter how low its price, while the labor at home is going to waste which might be employed in its production. Hence the necessity for every people to

build up thoroughly diversified industries at any cost and any sacrifice of present apparent cheapness. On this impregnable rock does the protectionist plant himself and defy the enemy, be he philosopher or be he boor.

### Money the Instrument of Association.

By means of the brilliant, all-pervading sunlight, which the recognition of the true place held by the law of association at the very foundation of society sheds upon the societary problem, the function of money assumes a new position, and the accumulated rubbish of centuries which has covered up and obscured it is completely brushed aside. In no other direction than that of the appreciation of the life-giving function of money, that of ministering to man's need for association and combination with his fellow-men, can we so confidently look for the emancipation of man himself.

Starting from the basic law of association, the Master has happily termed money *the instrument of association*, and it thus ceases to be the dead, inert thing which it has so long been supposed by the Greshams, the Smiths, the Humes, the Ricardos, the Huskissons, the Peels, the Overstones, the Mills, the assumption economists generally, and the army of so-called "statesmen," to be. Money, as the instrument of association, becomes a vitalizer, a producer, a utilizer of human labor power; a large volume of money, thus, under certain circumstances, being quite consistent with cheap production, as will be made more apparent in the sequel. Acknowledgment of the law of association as a basis, furnishes the only rational means of accounting for a host of problems touching money, which are of everyday occurrence and observation, although in direct antagonism to the theories of the philosophers.

The daily life of a civilized people, involving such countless millions of acts of association or commerce, such myriads of compositions, decompositions and recompositions of services, commodities and ideas, a medium having the qualities of universal acceptability and of almost unlimited divisibility and aggregation, is absolutely necessary to that life. In the early stages of society, and in isolated communities, there is but little societary life, and there man is dependent upon but comparatively few of his fellow-men, while in a city like London, Paris, New York, Philadelphia or Chicago there are many thousands of individuals, each of whom daily calls for the services of millions of men. Indeed, the purchaser of a copy of the *Herald*, *Tribune*, *Press* or *Ledger*, in making that purchase calls for the services of the millions of men who have, in any way, contributed to the production of one of these papers, even so remotely as by making the material of which the railroads or telegraphs have been constructed, by means of which the raw materials of the newspaper and the news have been conveyed all the way through from the miners of the coal, and the smelters of the metals, in the machinery used in its production, to the makers of the paper and the type, to the compositors, press-

ner, Jr., Patterson Du Bois, William W. Jefferis, Henry Phillips, Jr., Franklin Platt, Theodore D. Rand, J. G. Rosengarten, L. A. Scott, Coleman Sellers, Joseph Wharton, Joseph M. Wilson, Philadelphia; Mr. Heber S. Thompson, Pottsville, Pa.; Rev. F. A. Mühlenberg, Reading, Pa.; Dr. William Hyde Appleton, Swarthmore, Pa.; Dr. John Curwen, Warren, Pa.; Philosophical Society, Mr. Philip P. Sharples, Prof. J. T. Rothrock, West Chester, Pa.

Accessions to the Library were reported from the Royal Geographical Society, St. Petersburg, Russia; Ministerie van Binnenlandsche Sachen, The Hague; Verein für Beförderung des Gartenbaues, Berlin, Prussia; Verein für Schlesische Insektenkunde, Breslau, Prussia; Naturwissenschaftliche Verein, Kiel, Prussia; Royal Geological Society, Cornwall, Eng.; Royal Statistical Society, Geological Society, London, Eng.; Mr. A. McF. Davis, Cambridge, Mass.; Essex Institute, Salem, Mass.; University of the State of New York, Albany; Prof. Edward North, New York; Philadelphia Hospital, Forestry Association, Prof. George F. Barker, Philadelphia; Enoch Pratt Free Library, Baltimore, Md.; Bureau of Education, Anthropological Society, U. S. Naval Observatory, War Department, U. S. Coast and Geodetic Survey, Treasury Department, U. S. Fish Commission, Smithsonian Institution, U. S. National Museum, Dr. Albert S. Gatschet, Washington, D. C.; Artillery School, Fortress Monroe, Va.; Editor of the *Journal of Comparative Neurology*, Granville, Ohio; Michigan Board of Agriculture, Lansing; University of California, Berkeley; State Historical Society, Iowa City, Ia.; State Historical Society, Madison, Wis.; Kansas University, Lawrence; Asociacion de Ingenieros y Arquitectos, Observatoire Météorologique Central, Observatorio Astronómico N. de Tacubaya, Mexico, Mexico; Muséu Nacional, Rio de Janeiro, Brazil; Agricultural Experiment Stations, Kingston, R. I.; Lexington, Ky.; Lansing, Mich.; Berkeley, Cal.; St. Anthony Park, Minn.

Photographs for the Society's album were received from

Marquis de Nadaillac, Paris, France; Mrs. Helen Abbott Michael, Philadelphia.

The following deaths were reported:

George W. Childs, Philadelphia, February 3, 1894, æt. 64.

Rev. Henry S. Osborn, Oxford, Ohio, February, 1894.

The President was requested to prepare a note to be entered upon the minutes of the Society in reference to the death of Mr. Childs.

The Publication Committee reported that it would not be practicable to publish Dr. Wright's paper on the Water Supply. On motion the paper was ordered to be returned to its author.

The Secretaries reported that the paper by Prof. A. F. Chamberlin, entitled "The Botanical Names in the Language of the Kootenay Indians," was not desirable for publication.

This being the evening for voting for candidates for membership, pending nominations Nos. 1268, 1269, 1270, 1271, 1275 were read, spoken to and balloted for.

Action on pending nominations Nos. 1273 and 1274 was deferred until May 18, 1894.

The proceedings of the Board of Officers and Council were submitted.

Dr. Cope made a communication on "Energy in Evolution."

Dr. Brinton read a letter from Mr. J. C. Pilling in reference to a desired exchange, and the matter was referred to the Secretaries with power to act.

At the end of the evening, the votes cast having been counted, the tellers reported the state of the poll to the presiding member, who declared that the following had been duly elected members of the Society:

No. 2227. Colonel Henry A. DuPont, Wilmington, Del.

No. 2228. Sir Henry Bessemer, London.

No. 2229. Dr. Hermann Snellen, Utrecht.

No. 2230. Julius F. Sachse, Philadelphia.

And the Society was adjourned by the presiding member.

Iowa City, Ia.; University of California, Berkeley; Lick Observatory, Mt. Hamilton, Cal.; Prof. J. C. Branner, Palo Alto, Col.; Prof. Daniel Kirkwood, Riverside, Cal.; Prof. George Davidson, San Francisco, Cal.; Kansas University Quarterly, Lawrence; Kansas Academy of Science, Topeka; Academy of Sciences, Arts, and Letters, State Historical Society, Madison, Wis.; State Historical Society, Agricultural Experiment Station, Lincoln, Neb.; University of Wyoming, Laramie; Academy of Science, Tacoma, Wash.; Lieut. A. B. Wyckoff, North Lakima, Wash.; Central Meteorological Observatory, Sociedad-Cientifica "Antonio Alzate," Dr. Antonio Peñafiel, Mexico, Mexico; Agricultural Experiment Station, Las Cruces, N. M.

Accessions to the Library were reported from the Royal Society of South Australia, Adelaide; Prof. A. W. Bickerton, Christchurch, N. Z.; Société Impériale des Naturalestes, Moscow, Russia; Académie Impériale des Sciences, St. Petersburg, Russia; Section für Naturkunde des O. T. C., Anthropologische Gesellschaft, Vienna, Austria; K. P. Meteorologische Institut, Berlin, Prussia; Deutsche Gesellschaft für Anthropologie, etc., Munich, Bavaria; École Nat. Sup. des Mines, Bureau des Longitudes, Société Française dé Physique, Paris, France; Philological Society, Cambridge, Eng.; Geographical Society, Literary and Philosophical Society, Manchester, Eng.; Massachusetts Institute of Technology, Boston, Mass.; Harvard College, Cambridge, Mass.; Scientific Association, Meriden, Conn.; College of Physicians, Historical Society of Pennsylvania, Messrs. Henry Phillips, Jr., Frederick Prime, Philadelphia; Smithsonian Institution, Citizens' Association of the District of Columbia, Civil Service Commission, Washington, D. C.; Prof. Alexander Macfarlane, Austin, Texas.; Historical Society of Southern California, San Francisco; Prof. J. P. Walton, Muscatine, Ia.; Institute of Jamaica, Kingston; Agricultural Experiment Stations, Amherst, Mass.; Geneva, N. Y.; Experiment, Ga.; Baton Rouge, La.; Fort Collins, Colo.; Las Cruces, N. M.

Photographs for the Society's Album were rec

Yale University, Profs. O. C. Marsh, H. A. Newton, New Haven, Conn.; Prof. James Hall, Albany, N. Y.; Society of Natural Sciences, Buffalo, N. Y.; Prof. Edward North, Clinton, N. Y.; Prof. J. M. Hart, Ithaca, N. Y.; Historical Society, Academy of Medicine, New York Hospital, American Museum of Natural History, Meteorological Observatory, University of the City of New York, Profs. J. A. Allen, Isaac H. Hall, J. J. Stevenson, Messrs. Thomas C. Clarke, Charles P. Daly, James Douglas, New York, N. Y.; Prof. W. LeConte Stevens, Troy, N. Y.; Vassar Brothers' Institute, Poughkeepsie, N. Y.; Geological Society of America, Academy of Science, Rochester, N. Y.; Oneida Historical Society, Utica, N. Y.; Free Public Library, Jersey City, N. J.; Prof. Robert N. Rogers, Madison, N. J.; New Jersey Historical Society, Newark; Profs. Charles W. Shields, Charles A. Young, Princeton, N. J.; Prof. Charles F. Hines, Prof. Lyman B. Hall, Haverford, Pa.; Messrs. Charles H. Cramp, Louis Vossion, Samuel Wagner, Mrs. Helen Abbott-Michael, Philadelphia; Smithsonian Institution, United States Geological Survey, Surgeon-General's Office, United States Coast and Geodetic Survey, Weather Bureau, Col. Garrick Mallery, Prof. Charles A. Schott, Drs. John S. Billings, W. J. Hoffman, Mr. William B. Taylor, Washington, D. C.; Enoch Pratt Free Library, Maryland Institute, Prof. Ira Remsen, Baltimore, Md.; Mr. Thomas Leiper Patterson, Cumberland, Md.; Journal of the United States Artillery, Fortress Monroe, Va.; Prof. J. W. Mallet, University of Virginia, Elisha Mitchell Scientific Society, Chapel Hill, N. C.; Agricultural Experiment Station, Raleigh, N. C.; Georgia Historical Society, Savannah; University of Alabama, University P. O.; Texas Academy of Science, Austin; Agricultural Experiment Station, Knoxville, Tenn.; Prof. E. W. Claypole, Akron, O.; University of Cincinnati, Cincinnati Observatory, Cincinnati, O.; Editor of *The Journal of Neurology*, Granville, O.; Gen. W. F. Raynolds, Detroit, Mich.; Geological Survey, Jefferson City, Mo.; Purdue Experiment Station, Lafayette, Ind.; Society of Civil Engineers, Remington, Ind.; Academy of Natural Sciences, Davenport, Ia.; State Historical Society,

Iowa City, Ia.; University of California, Berkeley; Lick Observatory, Mt. Hamilton, Cal.; Prof. J. C. Branner, Palo Alto, Col.; Prof. Daniel Kirkwood, Riverside, Cal.; Prof. George Davidson, San Francisco, Cal.; Kansas University Quarterly, Lawrence; Kansas Academy of Science, Topeka; Academy of Sciences, Arts, and Letters, State Historical Society, Madison, Wis.; State Historical Society, Agricultural Experiment Station, Lincoln, Neb.; University of Wyoming, Laramie; Academy of Science, Tacoma, Wash.; Lieut. A. B. Wyckoff, North Lakima, Wash.; Central Meteorological Observatory, Sociedad-Cientifica "Antonio Alzate," Dr. Antonio Peñafiel, Mexico, Mexico; Agricultural Experiment Station, Las Cruces, N. M.

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Photographs for the Society's Album were received from

Dr. George R. Morehouse, Messrs. William V. McKean and Robert Patterson.

Dr. Rothrock read a paper on "The Present Condition and Future Prospect of the Pennsylvania Forests."

Dr. Morris corroborated the destruction of timber by insects as referred to in Dr. Rothrock's paper.

Dr. Morris read the following communication on "Tuberculosis in Animals:"

Some months since I was present at the slaughter of a herd of cattle on account of a dread of their being tainted with tuberculosis. This disease had been diagnosed as present in the original herd more than two months previously and all suspected animals had then been killed. The farmer, however, was not satisfied that the disease had been stamped out, and preferred to have the rest slaughtered while still in good condition for food as determined by experts who were present. In the lungs of two of them a few hard nodules were found, and on the intestinal walls of nearly all were small round masses which, on being incised, gave vent to a greenish, gritty, cheesy mass. In the opinion of the veterinary surgeon who was present these were not tubercular. They reminded me more of such small, cheesy masses as are often found in human post-mortem examinations and are apt to be disregarded unless found abundantly in subjects of true miliary tubercle when we often consider them as proof that the disease has become disseminated through the entire organism. With these exceptions, and also the occurrence of numerous vascular, subcutaneous lymphatics (called "beans" by the butcher boys), the cattle showed no disease, but, on the other hand, compared favorably with some Western steers which were slaughtered at the same time. The veterinary above mentioned called my attention to the comparative absence of these "beans" and small, yellowish-white bodies in the Western grain-fed stock and attributed their frequent or almost universal occurrence in Eastern cattle to something in the food or pasture grounds or water used by our cattle. This has set me to thinking whether there may not be some filaria or other intestinal parasite which causes such spurious cyst-like formations. But while waiting for opportunity to investigate this more closely, a gentleman observed to me that some gypsy boys whom he had played with in his youth had shown him a bottle which they said contained a poison prepared from mouldy hay, capable of producing sickness of a lingering, wasting character, terminating in death—like consumption in general character. Immediately the idea occurred to me that we *may* find in this direction the true nature and mode of action and dissemination of tubercle in the human family. The ex[illegible] asso[illegible]h the "bacillus tuberculosis" has led most obse[illegible] sid[illegible] as standing in causal relation to the

disease. Now this is a microscopic fungus; and it therefore seems to me there is no *à priori* improbability of its existence in musty hay and fodder; and when we consider the condition of food given to much of the live stock by improvident and unthrifty farmers a ready explanation of the spread of the disease now so generally dreaded is at hand. In speaking on the subject with Dr. Samuel G. Dixon, the distinguished bacteriologist, I found him fully alive to the possibilities of fruitful results from investigations into the transplantation of fungoid and actino-mycoid growths from a vegetable basis to animals; and that some German authorities have already done good work in this direction. Observations tending to establish an identity between the bacillus tuberculosis and other fungoid growths could not fail of being most important aids to us in combating the dread disease which sweeps away such a large portion of the human race. Nor should we forget that during the late war of the Rebellion a very fatal epidemic of "spotted fever," "black measles" or cerebro-spinal meningitis, as it was called, broke out among soldiers who were supplied with mouldy hay which was used for bedding. The epidemic spread by contagion quite extensively.

I have also been informed that the disease among horses known as cerebro-spinal meningitis is clearly traceable to mouldy hay; among the Dutch farmers near Lancaster it is called "putrid sorethroat," because the mucous membrane of the throat becomes inflamed and gangrenous, and the bolus of food is not swallowed, owing to paralysis of the muscles of deglutition We have thus as it were a connecting link with the phenomena of diphtheria, which is also traced to a mould or fungus which may grow upon any abraded, moist or mucous surface. The tendency of pathological investigations and studies during the past twenty years has been more and more towards the discovery of intimate causal relations between many diseases not formerly recognized as zymotic, and corresponding fungi or "bacteria" or "bacilli." We forget too often that these are only terms for microscopic fungi or moulds: that the same laws of propagation and growth govern them as their larger congeners: that the very term "zymotic" so long used in medical literature shows that our predecessors properly classed them as the results of "ferments:" and thus are liable to be led away from true methods of checking their ravages. Undoubtedly these are to be sought by better acquaintance with their life-conditions: and a large step in advance will have been made if we should be able to trace them from their ordinary and comparatively innocuous vegetable *habitats* to their dangerous migrations to animals. I do not know that in this connection attention has been drawn to the typhus-fever epidemics which have followed extensive vegetable disease, *e. g.*, the Irish potato rot: or the effect of ergotized rye and wheat on the poorer classes in Italy and the Balkan provinces. To return to the subject of tuberculosis in animals, including man: the conditions for its virulent spread are eminently those favoring fungous growths—deficient vital force (whether original or acquired from overstrain), damp dwellings, overheated viti-

ated air, and insufficient food. Add to these the germ, and the result is not long in showing itself. Take these away, and the germ is harmless, comparatively. A good illustration of this is to be found in the animals, especially the monkeys crowded together in our zoölogical gardens. What better field could be found for a properly conducted series of experiments on the thorough disinfection of air and food; isolation of infected individuals; and curative agents? The latter should embrace such bactericides as can enter the circulation harmlessly, and such natural food as will sustain the animals. The late Dr. Shippen's experience with the lessening of tuberculous and scrofulous disease among the colored inmates of the House of Refuge after the introduction of cornmeal as a large part of their diet should not be lost sight of. Might not a diet of cocoanuts and palmnuts be useful to our monkeys?

In conclusion, I would urge upon our microscopists the study of the whole class of moulds and fungi, both in their usual forms, and as to their transplanted forms in animal media and in living animals.

Pending nominations Nos. 1273 and 1274 were read.

On motion, it was

*Resolved,* That Rev. Robert W. Rogers, Ph.D., be appointed a delegate to represent the Society at the Congrés Internationale des Orientalistes, to be held at Geneva, in September, 1894, providing that the same shall entail no expense whatever upon the Society.

And the Society was adjourned by the President.

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## *Stated Meeting, March 16, 1894.*

Dr. J. Cheston Morris in the Chair.

Correspondence was submitted as follows:

A letter accepting membership from Sir Henry Bessemer, London, Eng.

An invitation from the Maryland Historical Society, Baltimore, to attend its Fiftieth Anniversary, March 12, 1894.

Letters of envoy were received from the Geological Survey of India, Calcutta; Société des Naturalistes, Moscow, Russia; K. Sächsiche Gesellschaft der Wissenschaften, Leipzig; Société d'Histoire Naturelle, Strassburg, Alsace.

On motion of Mr. Smyth, the Society appointed Messrs. Daniel G. Brinton and Henry Phillips, Jr., delegates to the meeting of the Congres International des Américanistes, to be held at Stockholm in September, 1894, providing that the same shall not entail any expense upon the Society.

The question of permitting persons connected with the public press to be present at the regular meetings of the Society, for the purpose of reporting the same for publication, was brought up by the Secretaries, and after considerable discussion the following resolution, offered by Dr. Daniel G. Brinton, was unanimously adopted:

That the Society disapprove of the presence of professional reporters, in their business capacity, at the regular meetings of the Society.

And the Society was adjourned by the President.

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*Stated Meeting, February 16, 1894.*

Mr. INGHAM in the Chair.

Letters of envoy were received from the Geologische Reichsanstalt, Vienna, Austria; Naturforschende Gesellschaft des Osterlandes, Altenburg, Germany; Verein für Schlesische Insektenkunde, Breslau, Germany; Naturwissenschaftliche Verein für Schleswig-Holstein, Kiel, Prussia; Royal Geological Society of Cornwall, Eng.; Royal Statistical Society, London, Eng.; Royal Irish Academy, Dublin, Ireland.

Letters of acknowledgment were received from the Institut Egyptien, Cairo (141); K. K. Geologische Reichsanstalt, K. K. Naturhistorische Hofmuseum, Vienna, Austria (141); K. P. Akademie der Wissenschaften (140); Botanische Verein d. Provinz Brandenburg (137, 138), Berlin, Prussia; Verein für Schlesische Insektenkunde, Breslau, Germany (139); Prof. H. von Helmholtz, Charlottenburg, Germany (138–141); Gartenbauverein, Darmstadt, Germany (139); K. Sächsische Alter-

thumsverein, Dresden (141); Naturwissenschaftliche Verein des Reg. Bez. Frankfort a.O. (141); Naturwissenschaftliche Verein für Schleswig-Holstein, Kiel, Prussia (135–139); Institut Lombardo di Scienze e Lettere, Milan, Italy; Académie R. des Sciences, Lettres, etc., Modena, Italy (130–135, and Transactions, xvi, 3); Société des Sciences Naturelles et Archeologique de la Creuse, Guéret, France (141); École Polytechnique, Dr. Edward Pepper, Paris, France (141); R. Academia de Ciencias y Artes, Barcelona, Spain (139); Public Library, Boston, Mass. (140); Prof. F. A. Genth, Jr., Lansdowne, Pa. (141); Dr. William H. Furness, Philadelphia (140, 141); Bureau of Ethnology, Washington, D. C. (96–135, 137, 138, 140, and Catalogue, Pts. i–iv); Wisconsin Academy of Sciences, Arts and Letters, Madison (119–141, and Catalogue, Pts. i–iv).

Letters of acknowledgment (142) were received from Dr. Charles B. Dudley, Altoona, Pa.; Dr. Robert H. Alison, Ardmore, Pa.; Prof. James E. Rhoads, Bryn Mawr, Pa.; Mr. Matthew H. Messchert, Douglassville, Pa.; Hon. Eckley B. Coxe, Drifton, Pa.; Prof. J. W. Moore, Rev. Thomas C. Porter, Easton, Pa.; State Library of Pennsylvania, Mr. Andrew S. McCreath, Harrisburg, Pa.; Mr. John Fulton, Johnstown, Pa.; Linnean Society, Lancaster, Pa.; Prof. F. A. Genth, Jr., Lansdowne, Pa.; Academy of Natural Sciences, Historical Society, Mercantile Library, College of Pharmacy, College of Physicians, Philadelphia Library, University of Pennsylvania, Editors of the *Medical News*, Wagner Free Institute, Gen'l Isaac J. Wistar, Hon. James T. Mitchell, Profs. John Ashhurst, J. Solis Cohen, E. D. Cope, Henry D. Gregory, L. M. Haupt, H. V. Hilprecht, Edwin J. Houston, E. Otis Kendall, J. P. Lesley, James MacAlister, Theophilus Parvin, Samuel P. Sadtler, Benjamin Sharp, Albert H. Smyth, Drs. D. G. Brinton, W. C. Cattell, William H. Furness, William H. Goodell, Francis W. Lewis, Morris Longstreth, John Marshall, Charles A. Oliver, W. S. W. Ruschenberger, Charles Schäffer, H. Clay Trumbull, William H. Wahl, Charles Stewart Wurts, Messrs. R. Meade Bache, Henry Carey Baird, Charles Bullock, S. Cast-

ner, Jr., Patterson Du Bois, William W. Jefferis, Henry Phillips, Jr., Franklin Platt, Theodore D. Rand, J. G. Rosengarten, L. A. Scott, Coleman Sellers, Joseph Wharton, Joseph M. Wilson, Philadelphia; Mr. Heber S. Thompson, Pottsville, Pa.; Rev. F. A. Mühlenberg, Reading, Pa.; Dr. William Hyde Appleton, Swarthmore, Pa.; Dr. John Curwen, Warren, Pa.; Philosophical Society, Mr. Philip P. Sharples, Prof. J. T. Rothrock, West Chester, Pa.

Accessions to the Library were reported from the Royal Geographical Society, St. Petersburg, Russia; Ministerie van Binnenlandsche Sachen, The Hague; Verein für Beförderung des Gartenbaues, Berlin, Prussia; Verein für Schlesische Insektenkunde, Breslau, Prussia; Naturwissenschaftliche Verein, Kiel, Prussia; Royal Geological Society, Cornwall, Eng.; Royal Statistical Society, Geological Society, London, Eng.; Mr. A. McF. Davis, Cambridge, Mass.; Essex Institute, Salem, Mass.; University of the State of New York, Albany; Prof. Edward North, New York; Philadelphia Hospital, Forestry Association, Prof. George F. Barker, Philadelphia; Enoch Pratt Free Library, Baltimore, Md.; Bureau of Education, Anthropological Society, U. S. Naval Observatory, War Department, U. S. Coast and Geodetic Survey, Treasury Department, U. S. Fish Commission, Smithsonian Institution, U. S. National Museum, Dr. Albert S. Gatschet, Washington, D. C.; Artillery School, Fortress Monroe, Va.; Editor of the *Journal of Comparative Neurology*, Granville, Ohio; Michigan Board of Agriculture, Lansing; University of California, Berkeley; State Historical Society, Iowa City, Ia.; State Historical Society, Madison, Wis.; Kansas University, Lawrence; Asociacion de Ingenieros y Arquitectos, Observatoire Météorologique Central, Observatorio Astronómico N. de Tacubaya, Mexico, Mexico; Muséu Nacional, Rio de Janeiro, Brazil; Agricultural Experiment Stations, Kingston, R. I.; Lexington, Ky.; Lansing, Mich.; Berkeley, Cal.; St. Anthony Park, Minn.

Photographs for the Society's album were received from

Marquis de Nadaillac, Paris, France; Mrs. Helen Abbott Michael, Philadelphia.

The following deaths were reported:

George W. Childs, Philadelphia, February 3, 1894, æt. 64.

Rev. Henry S. Osborn, Oxford, Ohio, February, 1894.

The President was requested to prepare a note to be entered upon the minutes of the Society in reference to the death of Mr. Childs.

The Publication Committee reported that it would not be practicable to publish Dr. Wright's paper on the Water Supply. On motion the paper was ordered to be returned to its author.

The Secretaries reported that the paper by Prof. A. F. Chamberlin, entitled "The Botanical Names in the Language of the Kootenay Indians," was not desirable for publication.

This being the evening for voting for candidates for membership, pending nominations Nos. 1268, 1269, 1270, 1271, 1275 were read, spoken to and balloted for.

Action on pending nominations Nos. 1273 and 1274 was deferred until May 18, 1894.

The proceedings of the Board of Officers and Council were submitted.

Dr. Cope made a communication on "Energy in Evolution."

Dr. Brinton read a letter from Mr. J. C. Pilling in reference to a desired exchange, and the matter was referred to the Secretaries with power to act.

At the end of the evening, the votes cast having been counted, the tellers reported the state of the poll to the presiding member, who declared that the following had been duly elected members of the Society:

No. 2227. Colonel Henry A. DuPont, Wilmington, Del.

No. 2228. Sir Henry Bessemer, London.

No. 2229. Dr. Hermann Snellen, Utrecht.

No. 2230. Julius F. Sachse, Philadelphia.

And the Society was adjourned by the presiding member.

*Stated Meeting, March 2, 1894.*

President, Mr. FRALEY, in the Chair.

Mr. Julius F. Sachse, a newly elected member, was presented to the Chair and took his seat.

Correspondence was submitted as follows:

A letter accepting membership was received from Col. Henry A. DuPont, Wilmington, Del.

A circular from the National Sculpture Society, New York, requesting the Society to become a member of same.

Letters of acknowledgment were received from the Hungarian Academy of Sciences, Budapest (138–141); Literary and Historical Society, Quebec, Canada (96–141, and Catalogue, Parts i–iv).

Letters of acknowledgment (142) were received from the Nova Scotia Institute of Science, Halifax; Mr. Horatio Hale, Clinton, Ontario; Geological Survey, Ottawa, Canada; Literary and Historical Society, University Laval, Quebec, Canada; Canadian Institute, Toronto, Canada; Manitoba Historical and Scientific Society, Winnipeg; Bowdoin College Library, Brunswick, Me.; Society of Natural History, Maine Historical Society, Portland, Me.; Dartmouth College Library, Hanover, N. H.; Vermont Historical Society, Montpelier; Massachusetts Historical Society, State Library of Massachusetts, Boston Society of Natural History, Boston Athenæum, Prof. T. M. Drown, Messrs. S. P. Sharples, Robert C. Winthrop, Boston, Mass.; Museum of Comparative Zoölogy, Prof. Alexander Agassiz, Mr. Robert R. Toppan, Cambridge, Mass.; Essex Institute, Salem, Mass.; Prof. Elihu Thomson, Swampscott, Mass.; Dr. James Ellis Humphrey, Weymouth Heights, Mass.; American Antiquarian Society, Worcester, Mass.; Rhode Island Agricultural Station, Kingston; Providence Franklin Society, Brown University, Rhode Island Historical Society, Providence, R. I.; Mr. George F. Dunning, Farmington, Conn.; Connecticut Historical Society, Hartford;

Yale University, Profs. O. C. Marsh, H. A. Newton, New Haven, Conn.; Prof. James Hall, Albany, N. Y.; Society of Natural Sciences, Buffalo, N. Y.; Prof. Edward North, Clinton, N. Y.; Prof. J. M. Hart, Ithaca, N. Y.; Historical Society, Academy of Medicine, New York Hospital, American Museum of Natural History, Meteorological Observatory, University of the City of New York, Profs. J. A. Allen, Isaac H. Hall, J. J. Stevenson, Messrs. Thomas C. Clarke, Charles P. Daly, James Douglas, New York, N. Y.; Prof. W. LeConte Stevens, Troy, N. Y.; Vassar Brothers' Institute, Poughkeepsie, N. Y.; Geological Society of America, Academy of Science, Rochester, N. Y.; Oneida Historical Society, Utica, N. Y.; Free Public Library, Jersey City, N. J.; Prof. Robert N. Rogers, Madison, N. J.; New Jersey Historical Society, Newark; Profs. Charles W. Shields, Charles A. Young, Princeton, N. J.; Prof. Charles F. Hines, Prof. Lyman B. Hall, Haverford, Pa.; Messrs. Charles H. Cramp, Louis Vossion, Samuel Wagner, Mrs. Helen Abbott-Michael, Philadelphia; Smithsonian Institution, United States Geological Survey, Surgeon-General's Office, United States Coast and Geodetic Survey, Weather Bureau, Col. Garrick Mallery, Prof. Charles A. Schott, Drs. John S. Billings, W. J. Hoffman, Mr. William B. Taylor, Washington, D. C.; Enoch Pratt Free Library, Maryland Institute, Prof. Ira Remsen, Baltimore, Md.; Mr. Thomas Leiper Patterson, Cumberland, Md.; Journal of the United States Artillery, Fortress Monroe, Va.; Prof. J. W. Mallet, University of Virginia, Elisha Mitchell Scientific Society, Chapel Hill, N. C.; Agricultural Experiment Station, Raleigh, N. C.; Georgia Historical Society, Savannah; University of Alabama, University P. O.; Texas Academy of Science, Austin; Agricultural Experiment Station, Knoxville, Tenn.; Prof. E. W. Claypole, Akron, O.; University of Cincinnati, Cincinnati Observatory, Cincinnati, O.; Editor of *The Journal of Neurology*, Granville, O.; Gen. W. F. Raynolds, Detroit, Mich.; Geological Survey, Jefferson City, Mo.; Purdue Experiment Station, Lafayette, Ind.; Society of Civil Engineers, Remington, Ind.; Academy of Natural Sciences, Davenport, Ia.; State Historical Society,

Iowa City, Ia.; University of California, Berkeley; Lick Observatory, Mt. Hamilton, Cal.; Prof. J. C. Branner, Palo Alto, Col.; Prof. Daniel Kirkwood, Riverside, Cal.; Prof. George Davidson, San Francisco, Cal.; Kansas University Quarterly, Lawrence; Kansas Academy of Science, Topeka; Academy of Sciences, Arts, and Letters, State Historical Society, Madison, Wis.; State Historical Society, Agricultural Experiment Station, Lincoln, Neb.; University of Wyoming, Laramie; Academy of Science, Tacoma, Wash.; Lieut. A. B. Wyckoff, North Lakima, Wash.; Central Meteorological Observatory, Sociedad-Cientifica "Antonio Alzate," Dr. Antonio Peñafiel, Mexico, Mexico; Agricultural Experiment Station, Las Cruces, N. M.

Accessions to the Library were reported from the Royal Society of South Australia, Adelaide; Prof. A. W. Bickerton, Christchurch, N. Z.; Société Impériale des Naturalestes, Moscow, Russia; Académie Impériale des Sciences, St. Petersburg, Russia; Section für Naturkunde des O. T. C., Anthropologische Gesellschaft, Vienna, Austria; K. P. Meteorologische Institut, Berlin, Prussia; Deutsche Gesellschaft für Anthropologie, etc., Munich, Bavaria; École Nat. Sup. des Mines, Bureau des Longitudes, Société Française dė Physique, Paris, France; Philological Society, Cambridge, Eng.; Geographical Society, Literary and Philosophical Society, Manchester, Eng.; Massachusetts Institute of Technology, Boston, Mass.; Harvard College, Cambridge, Mass.; Scientific Association, Meriden, Conn.; College of Physicians, Historical Society of Pennsylvania, Messrs. Henry Phillips, Jr., Frederick Prime, Philadelphia; Smithsonian Institution, Citizens' Association of the District of Columbia, Civil Service Commission, Washington, D. C.; Prof. Alexander Macfarlane, Austin, Texas.; Historical Society of Southern California, San Francisco; Prof. J. P. Walton, Muscatine, Ia.; Institute of Jamaica, Kingston; Agricultural Experiment Stations, Amherst, Mass.; Geneva, N. Y.; Experiment, Ga.; Baton Rouge, La.; Fort Collins, Colo.; Las Cruces, N. M.

Photographs for the Society's Album were received from

Dr. George R. Morehouse, Messrs. William V. McKean and Robert Patterson.

Dr. Rothrock read a paper on "The Present Condition and Future Prospect of the Pennsylvania Forests."

Dr. Morris corroborated the destruction of timber by insects as referred to in Dr. Rothrock's paper.

Dr. Morris read the following communication on "Tuberculosis in Animals:"

Some months since I was present at the slaughter of a herd of cattle on account of a dread of their being tainted with tuberculosis. This disease had been diagnosed as present in the original herd more than two months previously and all suspected animals had then been killed. The farmer, however, was not satisfied that the disease had been stamped out, and preferred to have the rest slaughtered while still in good condition for food as determined by experts who were present. In the lungs of two of them a few hard nodules were found, and on the intestinal walls of nearly all were small round masses which, on being incised, gave vent to a greenish, gritty, cheesy mass. In the opinion of the veterinary surgeon who was present these were not tubercular. They reminded me more of such small, cheesy masses as are often found in human post-mortem examinations and are apt to be disregarded unless found abundantly in subjects of true miliary tubercle when we often consider them as proof that the disease has become disseminated through the entire organism. With these exceptions, and also the occurrence of numerous vascular, subcutaneous lymphatics (called "beans" by the butcher boys), the cattle showed no disease, but, on the other hand, compared favorably with some Western steers which were slaughtered at the same time. The veterinary above mentioned called my attention to the comparative absence of these "beans" and small, yellowish-white bodies in the Western grain-fed stock and attributed their frequent or almost universal occurrence in Eastern cattle to something in the food or pasture grounds or water used by our cattle. This has set me to thinking whether there may not be some filaria or other intestinal parasite which causes such spurious cyst-like formations. But while waiting for opportunity to investigate this more closely, a gentleman observed to me that some gypsy boys whom he had played with in his youth had shown him a bottle which they said contained a poison prepared from mouldy hay, capable of producing sickness of a lingering, wasting character, terminating in death—like consumption in general character. Immediately the idea occurred to me that we *may* find in this direction the true nature and mode of action and dissemination of tubercle in the human family. The extent of its association with the "bacillus tuberculosis" has led most observers to consider the latter as standing in causal relation to the

disease. Now this is a microscopic fungus; and it therefore seems to me there is no *à priori* improbability of its existence in musty hay and fodder; and when we consider the condition of food given to much of the live stock by improvident and unthrifty farmers a ready explanation of the spread of the disease now so generally dreaded is at hand. In speaking on the subject with Dr. Samuel G. Dixon, the distinguished bacteriologist, I found him fully alive to the possibilities of fruitful results from investigations into the transplantation of fungoid and actino-mycoid growths from a vegetable basis to animals; and that some German authorities have already done good work in this direction. Observations tending to establish an identity between the bacillus tuberculosis and other fungoid growths could not fail of being most important aids to us in combating the dread disease which sweeps away such a large portion of the human race. Nor should we forget that during the late war of the Rebellion a very fatal epidemic of "spotted fever," "black measles" or cerebro-spinal meningitis, as it was called, broke out among soldiers who were supplied with mouldy hay which was used for bedding. The epidemic spread by contagion quite extensively.

I have also been informed that the disease among horses known as cerebro-spinal meningitis is clearly traceable to mouldy hay; among the Dutch farmers near Lancaster it is called "putrid sorethroat," because the mucous membrane of the throat becomes inflamed and gangrenous, and the bolus of food is not swallowed, owing to paralysis of the muscles of deglutition We have thus as it were a connecting link with the phenomena of diphtheria, which is also traced to a mould or fungus which may grow upon any abraded, moist or mucous surface. The tendency of pathological investigations and studies during the past twenty years has been more and more towards the discovery of intimate causal relations between many diseases not formerly recognized as zymotic, and corresponding fungi or "bacteria" or "bacilli." We forget too often that these are only terms for microscopic fungi or moulds: that the same laws of propagation and growth govern them as their larger congeners: that the very term "zymotic" so long used in medical literature shows that our predecessors properly classed them as the results of "ferments:" and thus are liable to be led away from true methods of checking their ravages. Undoubtedly these are to be sought by better acquaintance with their life-conditions: and a large step in advance will have been made if we should be able to trace them from their ordinary and comparatively innocuous vegetable *habitats* to their dangerous migrations to animals. I do not know that in this connection attention has been drawn to the typhus-fever epidemics which have followed extensive vegetable disease, *e. g.*, the Irish potato rot: or the effect of ergotized rye and wheat on the poorer classes in Italy and the Balkan provinces. To return to the subject of tuberculosis in animals, including man: the conditions for its virulent spread are eminently those favoring fungous growths—deficient vital force (whether original or acquired from overstrain), damp dwellings, overheated viti-

ated air, and insufficient food. Add to these the germ, and the result is not long in showing itself. Take these away, and the germ is harmless, comparatively. A good illustration of this is to be found in the animals, especially the monkeys crowded together in our zoölogical gardens. What better field could be found for a properly conducted series of experiments on the thorough disinfection of air and food; isolation of infected individuals; and curative agents? The latter should embrace such bactericides as can enter the circulation harmlessly, and such natural food as will sustain the animals. The late Dr. Shippen's experience with the lessening of tuberculous and scrofulous disease among the colored inmates of the House of Refuge after the introduction of cornmeal as a large part of their diet should not be lost sight of. Might not a diet of cocoanuts and palmnuts be useful to our monkeys?

In conclusion, I would urge upon our microscopists the study of the whole class of moulds and fungi, both in their usual forms, and as to their transplanted forms in animal media and in living animals.

Pending nominations Nos. 1273 and 1274 were read.

On motion, it was

*Resolved*, That Rev. Robert W. Rogers, Ph.D., be appointed a delegate to represent the Society at the Congrés Internationale des Orientalistes, to be held at Geneva, in September, 1894, providing that the same shall entail no expense whatever upon the Society.

And the Society was adjourned by the President.

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*Stated Meeting, March 16, 1894.*

Dr. J. Cheston Morris in the Chair.

Correspondence was submitted as follows:

A letter accepting membership from Sir Henry Bessemer, London, Eng.

An invitation from the Maryland Historical Society, Baltimore, to attend its Fiftieth Anniversary, March 12, 1894.

Letters of envoy were received from the Geological Survey of India, Calcutta; Société des Naturalistes, Moscow, Russia; K. Sächsiche Gesellschaft der Wissenschaften, Leipzig; Société d'Histoire Naturelle, Strassburg, Alsace.

Letters of acknowledgment were received from the K. K. Sternwarte, Prague, Bohemia (141); Société d'Histoire Naturelle, Strassburg (140, 141); Prof. Abel Hovelacque, Paris, France (141); Dr. Traill Green, Easton, Pa. (142); Prof. John F. Carll, Pleasantville, Pa. (142); Mr. Jedediah Hotchkiss, Staunton, Va. (142); Scientific Society, Denver, Colo. (142); Central Meteorological Observatory, Mexico, Mexico (140, 141); Observatorio Astrónómico Nacional Mexicano, Tacubaya (142); Instituto fisico-geografico Nacional, San José de Costa Rica, C. A. (141); Museo Nacional, Buenos Aires, S. A. (139, 140, 141).

Accessions to the Library were reported from the Geological Survey of India, Calcutta; Statistica Central Byran, Stockholm, Sweden; K. K. Zoologisch-botanische Gesellschaft, Prof. Karl Penka, Vienna, Austria; Gesellschaft für Erdkunde, Berlin, Prussia; Naturforschende Gesellschaft, Freiburg i. B.; Société d'Histoire Naturelle, Strassburg, Alsace; Naturforschende Gesellschaft, Zurich, Switzerland; "Il Nuovo Cimento," Pisa, Tuscany; Université de Lyon, France; Instituto y Observatorio de Marina, San Fernando, Spain; R. Meteorological Society, London, Eng.; Royal Society, Edinburgh, Scotland; Theological Seminary, Andover, Mass.; Commission of Public Records, Boston, Mass.; Mr. Walter S. Logan, New York, N. Y.; Hon. Robert E. Pattison, Harrisburg, Pa.; Dr. C. S. Dolley, Philadelphia; California Academy of Sciences, San Francisco; Historical Society, Chicago, Ill.; Experiment Stations, Raleigh, N. C.; Ames, Ia.; Lincoln, Neb.; Corvallis, Oreg.

The death of Cavaliere Damiano Muoni, Milan, Italy, February 22, 1894, æt. 74, was announced.*

* Cavaliere Damiano Muoni was born at Antignate, Province of Bergamo, Italy, on the fourteenth day of August, 1820. His early life was studious, and his ambitions patriotic. He participated in the ill-starred insurrection, "le cinque giornate," of 1848, at Milan, and in consequence was obliged to be absent from his country for a long period. His time was filled with study, and he returned the possessor of much valuable historical and archæological matter. His activity in authorship was unceasing, and over one hundred books, pamphlets, papers, etc., attest his proficiency in history, genealogy, archæology, fine arts, and other branches of knowledge. He held the position of State Archivist for many years, and was zealous, courteous and obliging.

Mr. Henry C. Baird read a paper entitled "Association: The Dominating Need of Man, and the Keystone of Social Science."

After which a desultory discussion on the subject of the paper took place.

Pending nominations Nos. 1273 and 1274, and new nominations Nos. 1276 to 1296 inclusive were read.

And the Society was adjourned by the presiding member.

PROCEEDINGS

OF THE

# AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA FOR PROMOTING USEFUL KNOWLEDGE.

VOL. XXXIII. JUNE, 1894. No. 145.

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☞ It is requested that the receipt of this number be acknowledged.

☞ In order to secure prompt attention it is requested that all correspondence be addressed simply "To the Secretaries of the American Philosophical Society, 104 S. Fifth St., Philadelphia."

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# EXTRACT FROM THE LAWS.

THE HENRY M. PHILLIPS PRIZE ESSAY FUND.

Miss Emily Phillips, of Philadelphia, a sister of Hon. Henry M. Phillips, deceased, presented to the American Philosophical Society, held at Philadelphia for Promoting Useful Knowledge, the sum of five thousand dollars for the establishment and endowment of a Prize Fund, in memory of her deceased brother, who was an honored member of the Society. The Society accepted the gift and agreed to make suitable rules and regulations to carry out the wishes of the donor, and to discharge the duties confided to it. In furtherance whereof, the following rules and regulations were adopted by the Society:

*First.* The Prize Endowment Fund shall be called the "Henry M. Phillips Prize Essay Fund."

*Second.* The money constituting the Endowment Fund, *viz.*, five thousand dollars, shall be invested by the Society in such securities as may be recognized by the laws of Pennsylvania, as proper for the investment of trust funds, and the evidences of such investment shall be made in the name of the Society as Trustee of the Henry M. Phillips Prize Essay Fund.

*Third.* The income arising from such investment shall be appropriated as follows:

(*a*) To making public advertisement of the prize and the sum or amount in United States gold coin, and the terms on which it shall be awarded.

(*b*) To the payment of such prize or prizes as may from time to time be awarded by the Society for the best essay of real merit on

PROCEEDINGS

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VOL. XXXIII. JUNE, 1894. No. 145.

## *Stated Meeting, April 6, 1894.*

Vice-President KENDALL in the Chair.

Minutes of last meeting read.

Correspondence was submitted as follows:

Letter accepting membership from Dr. Isaac Roberts, Starfield, Crowborough, Sussex, England.

Circular letter from the Directeur of the Direction Générale de Statistique, of the Province of Buenos Ayres, announcing his appointment to that office.

Accessions to the Library were reported from Mr. Edward Counsel, Melbourne, Australia; Mr. N. A. Cobb, Sydney, Australia; Bataafsch Genootschap, Rotterdam, Netherlands; K. K. Naturhistorische Hofmuseum, Vienna, Austria; Gesellschaft für Erdkunde, Deutsche Seewarte, Berlin, Prussia; K. Gesellschaft der Wissenschaften, Göttingen, Prussia; Würtembergische Kommission für Landesgeschichte, Stuttgart; R. Istituto Lombardo, Milan, Italy; Società Italiana delle Scienze, Naples, Italy; R. Accademia delle Scienze, Turin, Italy; Académie des Sciences, etc., Angers, France; Académie N. des Sciences, etc., Caen, France; Société des Sciences Naturelles et Archéologiques de la Creuse, Guéret, France; Dr. P. Topinard, Paris, France; Société des Antiquaires de la Morinie, Saint-Omer, France; Historical Society, Dr. Hugh

Hamilton, New York, N. Y.; University of Pennsylvania, Dr. William F. Norris, Philadelphia; U. S. Naval Institute, Annapolis, Md.; Smithsonian Institution, Bureau of Education, U. S. Coast and Geodetic Survey, Washington, D. C.; Director of the Michigan Mining School, Lansing; Dr. Jesus Diaz de Leon, Aguascalientes, Mexico.

The following deaths were announced:

Dr. E. Brown-Sequard (Paris, France), born 1818, died April 2, 1894.

Sir P. Cunliffe Owen (London, Eng.), born June 8, 1828, died March 23, 1894.

Hon. Washington Townsend (West Chester, Pa.), died March 18, 1894, æt. 82.

Obituary notice of Thomas M. Cleemann was read by Mr. Prime.

Prof. Cope made a communication on some points of the anatomy of the Ophidia, especially regarding the lungs.

Mr. Lyman offered for the Proceedings a map of the New Red, New Jersey.

Pending nominations Nos. 1273 and 1274, 1276 to 1296, and new nominations Nos. 1297 and 1298 were read.

And the Society was adjourned by the Chairman.

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*Stated Meeting, April 20, 1894.*

Vice-President, Mr. KENDALL in the Chair.

Minutes of meeting, April 6, read.

Correspondence was submitted as follows:

Letters of envoy were received from the K. Meteorologische Institut, Berlin, Prussia; Editors of *Nuovo Cimento*, Pisa, Italy; Musée Guimet, Ministere des Travaux Publics, Paris, France; U. S. Coast and Geodetic Survey, Washington, D. C.

Letters of acknowledgment were received from the Bibliothèque de l'Université Royale, Lund, Sweden (140, 141); K. D. Videnskabernes Selskab, Copenhagen, Denmark (Trans., xvii, 3, xviii, 1; Proc., 141); K. Zoologisch Genootschap "Natura Artis Magistra," Amsterdam, Netherlands (142); K. Zoologisch-Botanische Genootschap, 's Gravenhage, Netherlands (142); Kolonial Museum, Fondation de P. Teyler van der Hulst, Haarlem, Netherlands (142); Prof. G. Tschermak, Vienna, Austria (140, 141); K. Gesellschaft der Wissenschaften, Göttingen, Prussia (141); Observatorio Astronomico della R. Università, Turin, Italy (141); Société d'Anthropologie, Paris, France (140, 141); U. S. Naval Observatory, Washington, D. C. (142); Society of Natural History, Cincinnati, O. (142); Historical Society of Southern California, Los Angeles (96–142, and Catalogue, Parts i–iv); Kansas State Historical Society, Topeka (142); Observatoire Météorologique Central de Mexico, Mexico (140–142, and Catalogue, Parts i–iii); Bishop Crescenzio Carrello Ancora, Mirida, Yucatan, Mexico (142).

Accessions to the Library were reported from the Exhibition Trustees, Melbourne, Australia; Lund University, Lund, Sweden; Academie R. des Sciences, etc., Copenhagen, Denmark; Akademie der Wissenschaften, Physikalische Gesellschaft, Berlin, Prussia; Bath and West of England, etc., Society, Bath, Eng.; Philosophical Society, Cambridge, Eng.; Society of Antiquaries, London, Eng.; Amer. Academy of Arts and Sciences, Massachusetts Historical Society, Dr. Samuel A. Green, Boston, Mass.; Public Library, Salem, Mass.; Tufts College, Mass.; Academy of Sciences, New York, N. Y.; Dr. D. Jayne & Son, Philadelphia; Enoch Pratt Free Library, Baltimore, Md.; Elisha Mitchell Scientific Society, Chapel Hill, N. C.; Society of Natural History, Cincinnati, O.; Mr. S. Waterhouse, St. Louis, Mo.; Agricultural Experiment Stations, Orono, Me., Burlington, Vt., Amherst, Mass., Storrs, Conn., Blacksburg, Va., Columbia, Mo.

Announcement of death:

Dr. William V. Keating, Philadelphia, April 18, 1894, æt. 71.

On motion, the President was authorized to appoint a suitable person to prepare the usual obituary notice.

Mr. Price offered the following:

*Resolved*, That a Committee of three members of the Society be appointed to confer with the representatives of other societies and organizations, with reference to a public dinner which it has been proposed to give the Hon. Frederick Fraley, the President of this Society, on the 28th day of May, the ninetieth anniversary of his birth.

The following Committee was appointed: Messrs. Price, Vaux and Dr. Brinton.

Mr. Bache read an article explanatory of the Brownian movements. Dr. Brinton made some remarks on the subject.

Pending nominations 1273, 1274, 1276 to 1298, and new nominations 1299 and 1300 were read.

Mr. Prime offered the following resolution, which was seconded by Dr. Brinton:

*Resolved*, That a Committee of five members be appointed by the President to take into consideration the state of the Society, and to report whether any, and if any, what measures it may be expedient to take for increasing the resident membership of the Society, and promoting its usefulness; and whether in effectuating these purposes it may be necessary to amend the existing laws and regulations.

The matter was discussed by Messrs. Prime, Brinton, Price, Horn and Lyman.

On motion, the resolution was adopted.

The President subsequently appointed the following Committee:

Frederick Prime, *Chairman*, J. Sergeant Price, George H. Horn, William P. Tatham, J. G. Rosengarten.

And the Society was adjourned.

# *The Secret of the Brownian Movements.*

*By R. Meade Bache.*

(*Read before the American Philosophical Society, April 20, 1894.*)

We first hear systematically of molecular movement, as a thing directly visible, from the writings of the distinguished botanist, Dr. Robert Brown, embodied in a paper entitled, "A Brief Account of Microscopical Observations, Made in the Months of June, July, and August, 1827, On the Particles Contained in the Pollen of Plants; and On the General Existence of Active Molecules in Organic and Inorganic Bodies."

Of course we know inferentially, through physics and chemistry, that the particles of bodies move under the influence of various extraneous forces, and we know, too, that, in the case of matter in a gaseous form, they move also under the influence of force inherent in their own constitution. But the movements of which I am about to speak relate to the visible behavior of what should be termed inert matter, if that expression were not begging the question of whether or not it has in itself power of motion, and thus deciding it in favor of the view that it has not, but is moved by extraneous force. We must begin, therefore, as is but right, by assuming that it is an open question as to whether or not certain particles, in aqueous suspension, call them molecules or otherwise, as one pleases, organic or inorganic, but not endowed with animal life, are of themselves capable of movement, or are moved by some extraneous force or forces at present unknown. The solid ground of fact from which we start is that, under the conditions mentioned, they do move, for that is undeniable and admitted.

Dr. Brown soon discarded, through disproving in the course of his investigations the surmise which he had made, that the particles of pollen indicated by their motion a mode of function analogous to that of spermatozoids, and rested eventually in the conclusion that particles moving in aqueous solutions are not confined to organic bodies or to their products. He had conducted a series of experiments on finely crushed glass, on simple earths and metals, with many of their combinations, and rocks of all ages, including those in which no organic remains have ever been found. Moving particles presented themselves in each of the constituent

minerals of granite. Even a crushed fragment of the Sphynx gave the same results. He tried substances of both aqueous and igneous origin, travertine, stalactites, lava, obsidian, volcanic ashes, meteoric matter, manganese, nickel, plumbago, bismuth, antimony, arsenic, asbestos, actinolite, tremolite, zeolite, and steatite. He tried particles of wood, living and dead, linen, paper, cotton, silk, wool, hair, and muscular fibre that had been exposed to fire under the blowpipe, douched with water, and submitted to immediate examination. The particles from all these substances exhibited as vivid movement after as before they had been so treated.

Dr. Brown, about twelve months later, went on further to declare, under the head of "Additional Remarks on Active Molecules," that:—"The result of the inquiry at present essentially agrees with that which may be collected from my printed account, and may be here briefly stated in the following terms; namely, that extremely minute particles of solid matter, whether obtained from organic or inorganic substances, when suspended in pure water, or in some other aqueous fluids, exhibit motions for which I am unable to account, and which, from their irregularity and seeming independence, resemble in a remarkable degree the less rapid motions of some of the simplest animalcules of infusions. That the smallest moving particles observed, and which I have termed Active Molecules, appear to be spherical, or nearly so, and to be between 1-20,000 and 1-30,000 of an inch in diameter; and that other particles of considerably greater and various size, and either of similar or of very different figure, also present analogous motions in like circumstances. I have formerly stated my belief that these motions of the particles neither arose from currents in the fluid containing them, nor depended on the intestine motion which may be supposed to accompany its evaporation. These causes of motion, however, either singly or combined with others,—as, the attractions and repulsions among the particles themselves, their unstable equilibrium in the fluid in which they are suspended, their hygrometrical or capillary action, and in some cases the disengagement of volatile matter, or of minute air bubbles,—have been considered by several writers as sufficiently accounting for the appearance. Some of the alleged causes here stated, with others which I have considered it unnecessary to mention, are not likely to be overlooked or to deceive observers of any experience in microscopical research; and the insufficiency of the most important of those enumerated, may, I

think, be satisfactorily shown by means of a very simple experiment." [Dr. Brown here alludes to what he details at considerable length, as to the trituration together of oil and water, so as to secure, in one case, by a large proportion of water to oil, lacunæ of water of various sizes, filled with particles, protected from evaporation by the oil, and in the converse case, by a small proportion of oil to water, to secure minute oil-drops on the surface of the water, some of which drops were not larger than the solid particles in the water.]

These passages from the writings on this subject of so skillful, careful, and conscientious an observer as Dr. Brown was, excite regret that he had not pursued the subject further. He would have found, among other things, a much simpler and more lasting method of excluding air from the drop under observation, than that which he adopted in forming lacunæ of aqueous fluid protected from evaporation by immersion in oil. He would in all probability have discovered the real cause of the motion of organic and inorganic particles in aqueous fluids. But he dropped the subject, perhaps because he was obliged so to do on account of the pressure of other research, when he had obtained some valuable results, leaving his investigations negative as to conclusions. He doubtless began with the supposition, which seems common at first to all investigators of the subject, that evaporation might represent a shock that would move the particles suspended in water; that vibration from mechanical sources might account for the movements; that currents set up in the drop of water by differences of temperature in it or slight differences in the temperature of the air surrounding it, might account for them; or that mutual attractions, derived from gravitation, and inherent in the relative density of the particles themselves, might do so; and he found, as every one else will find who experiments in these directions, that the movements go on independently of currents and independently of heat, generating or not generating currents, independently of light, and in the case where the particles represent an extremely fine division of matter, and are at the same time of low specific gravity, even independently of terrestrial gravitation; and without relation to their specific gravity, with the force of their mutual gravitation entirely masked.

Some of these things Dr. Brown implies that he saw in the course of his investigations; others he could hardly have failed incidentally

to see, but one that I have mentioned, he did not rightly interpret. It was a distinct lapse in his acuteness of observation, that involved in his mention, without perception of its deepest significance, of minute drops of oil, some of them not exceeding the solid particles themselves in size, standing nearly or altogether at rest on the surface of water; the pointing of which fact is very clear, one which, had it been known to me, would have induced me to try oil as well as water among the first instead of among the last of my own experiments, as actually happened in their sequence.

To afford facility for the fullest comprehension of the subject, it becomes proper here to resume the historical tenor of our way with a brief account of some of the views of Herren Wiener, Exner, and Schultze, more recent than those of Dr. Brown. In order to avoid the responsibility for the necessary condensation, I prefer to quote, as follows, from the summary of their views in the *Jahresbericht* of 1867:

"Then Chr. Wiener, from whose account the preceding historical remarks are quoted, instituted microscopic observations of these movements, and came to the conclusion that this trembling, irregular, unsteady motion of solid molecules, which alter their direction in the briefest fraction of time in their zigzag course, has for its basis the continual movements which, by virtue of their molecular constitution, belong to fluids. He learned through his investigations (1) that the movements are not those of infusoria; (2) that the movement is not communicated to the fluid; (3) that the trembling movement is not in any way derived from the varying attraction and collision of the various oscillating molecules with one another; (4) that the movement is not derived from changes of temperature; (5) that, also, the movement is not derived from evaporation. Consequently, there remained to him nothing to ascribe as the cause of the peculiar movements but the property of the fluid itself. This explanation received direct confirmation from Wiener's observation, that the amount of the movement has a certain relation to the size of the molecule. Lately S. Exner has extended the investigations of Wiener. Among the various influences which Exner sought to test with reference to the molecular motion was whether either chemical causes or mechanical ones, such as pressure, vibration, and so forth, could in any way produce an acceleration or a retardation of the effect. Only by exposure to light and heat did the motion become accelerated, and then in such a manner as,

in the case of glycerin, the molecules of which under ordinary conditions show scarcely any, if any movement at all, to exhibit it clearly when warmed up to fifty degrees centigrade of temperature. Exner also examined into the properties of fluids in which solid molecules remain suspended. The results of his investigation resolve themselves into the following points: (1) The liveliness of the molecular movement is heightened by light and heat, and by radiant as well as by conducted heat; (2) one of the consequences of the molecular movement is, that the molecules, in a specifically lighter fluid, not only do not sink to the bottom, but overcome the force of gravitation to such a degree as to spread themselves equally throughout the fluid; (3) the velocity of this scattering is as the intensity of the molecular movements influenced by light and heat. It should be mentioned here that Fr. Schultze had already stated that substances, when most finely divided, especially such as seemed under the microscope to be amorphous, and exhibited the brownian movements, remain suspended in pure water and in many other fluids for days, weeks, and months at a time, so that the fluid containing them presents a cloudy, or at least an opalescent appearance."

The account of the views of Herr Wiener in the *Jahresbericht* makes an important omission. It devotes itself chiefly to reciting what, in his view, does not cause the brownian movements, but does not mention precisely to what he does ascribe them. Herr Wiener says, in the last paragraph of his article, in *Poggendorf's Annalen*, 1863:—"The weight of the preceding conclusion, that one cannot ascribe the trembling movement to any exterior cause, is very greatly added to by the ascertained fact, that the diameter of the similarly moved water masses is so small that it nearly corresponds with the wave-length of red light, and still more closely with that of radiant heat." This passage gives the keynote to his views on the brownian movements. After a most elaborate series of experiments, in which he measured on a micrometrically divided glass slide, with the addition of diagonal lines, and by watch, the range and the time of the movements, he reached his most important conclusion, that, because the dimensions of the aforesaid wave-lengths of light and heat have a certain close correspondence with the diameters of the minutest particles and water masses, they form the moving impulse of the motions of the particles. He pictured to himself that the æther surrounding the particles, being continu-

ous with the æther of space, acts, through the rays of light and heat on the particles and minute water masses, generating in their interaction, as the visible resultant of the forces in play, the movement of the particles in suspension in aqueous solutions. But, if the cause of the movements assigned by Herr Wiener were the true one, the same cause ought to be operative in the case of alcohol and in that of the fixed and volatile oils: but it is not. This conclusion of Herr Wiener's seems to me to be derived from the unsatisfactory fact of a coincidence, of which kind of proof we habitually perceive more than enough to obscure, bewilder, and often to baffle our feeble efforts to penetrate beyond the veil of phenomena, of things as they seem, to the everlasting noumena, things as they are, near the inscrutable throne of nature.

I will not weary my hearers with the recital of the numerous details of my own experiments, the names of the substances that I tried, the modes in which they were treated, the manipulations of various sorts necessary to the prosecution of the work. Every one knows the difficulties that will arise in new investigations, which will themselves suggest the means of countervailing them as the work proceeds. In this particular case one difficulty was to obtain finely enough divided matter in other liquids besides water. It may be interesting to mention that I did not read anything on the subject until my own experiments were nearly finished. By this course I avoided any possible bias expressed or implied in the directions to be pursued and the conclusions to be drawn, and I had ultimately the satisfaction to perceive, as I had often before observed, how, owing to the constitution of the mind, men necessarily follow the same general and often particular track in their procedures. It is not in the course they follow, that they differ much, but in the conclusions which they reach in pursuing what is virtually the same way. Fortunately for me, constrained to be absent for months in the field on geodetic duty, and at all times constantly engaged at my profession, night still lent itself to my slowly accumulated results. That the investigation was most interesting, I need hardly say.

As electric currents have been demonstrated in the human body, I naturally thought that all slight differences of tension between the liquid and particles, or in the liquid itself, might set up electric currents. Therefore I passed the galvanic current through liquids filled with particles, watching them carefully. There was not the slightest

visible effect thereby produced on the movements of the particles. If the movements had been produced by electric currents, then so strong a current as I often passed through a drop of water ought to have left no manifestation of movement possible from the necessarily weak, if actually existing, currents supposed to be actuating the particles. The molecular movement, so-called, is, as described by Herr Wiener, a zigzag one, but that term does not exactly convey the peculiarity of the motion. It is a combination of a jerky, wobbling movement, performed within determinate bounds, entirely irrespective of the sweep of currents in the liquid, or even of the effects in some cases of terrestrial gravity, and in no case seemingly affected by the influence of local gravitation of particle to particle. Taking the vermilion of the sulphide of mercury, as finely divided as it can be made, and turning the microscope at even a slight angle from the vertical, the effect of terrestrial gravity on the particles becomes at once apparent, but taking the carmine, reputedly made of cochineal, the particles are not affected in the slightest degree by terrestrial gravity. Of course it is hardly necessary to say that any solution should be weak, in order to allow the substances under examination to receive the finest division of which each is susceptible as dissolved. The specific gravity of sulphide of mercury is not only much greater than that of cochineal, but additionally it is not susceptible of nearly so minute division as cochineal is. Of all substances that I experimented with, cochineal seemed to be that which is capable of the finest division, and at the same time of the most brilliant illumination. Gamboge, which appears to be the substance of predilection among many persons to experiment with for the brownian movements, offers nothing comparable to the brilliancy and the fineness of particles of carmine derived from cochineal. With a weak aqueous solution of carmine one may see by daylight, on a background of faint blue, and by ordinary artificial light, on a golden one, thousands of tiny particles, bright as sparks of ruby, shimmering and performing their independent evolutions over the field of view.

Just as one sees a boat managed by an unskillful helmsman pursue its erratic way in going about, being taken aback, or heeled over by a flaw of wind, without for a moment attributing its movements to currents or any other cause but the true one, so the constant observer of the brownian movements knows full well that the particles themselves are moving, not being moved by currents or by gravitation

towards the earth or among themselves. He, from the first, recognizes the fact that the smaller the particles are, the more vivid is their movement. He recognizes another, that, although many large particles do not, as masses, move at all, yet the larger masses are all alive, as it were, with smaller ones, seen clearly around their periphery, on the silhouette of which they are seen plying like banks of oars in an ancient trireme. He is struck with and convinced of still another thing, that whereas one might expect to find that all particles would manifest an attraction for each other through gravitation, and that the larger and largest, but all in proportion to their relative size, would attract and absorb the relatively smaller and smallest ones, nothing of the kind occurs, but the smaller, down to the smallest, go their own way, sometimes even touching the largest and bounding off and away as if they do not, as indeed they do not visibly, submit to the force of gravitation. Of course they cannot escape the influence of gravitation, whether terrestrial or among themselves, but the effect of gravitation upon them is masked, in what manner will appear later.

It seemed to me that magnetic earth-waves might affect particles in such delicate suspension as those of which we are speaking, some of which are no greater in diameter than 1-100,000 of an inch, seen under various powers capable of magnifying from 650 to 1300 diameters. Accordingly, I have placed the particular fluid under examination in the lines of force of a permanent magnet, with the magnet on one side and the keeper on the other of the drop of fluid. Concentrating the gaze on individual particles, to observe if their movement were modified, and then on others in succession, and often repeating the experiment, nothing could be observed other than the movements existing before the magnet had been brought into requisition. The only kind of particles susceptible to the influence of the magnet were those of precipitated iron, but iron is always obedient to the magnet.

Heat I applied in various ways, either irregularly or in an endeavor to distribute it as equably as possible on the glass slide on which the particular experiment was made. Mere currents are set up during the adjustment of temperature from radiation. At the same time one can observe and differentiate the motions due to the brownian movements, the motions along currents, and also the motions from terrestrial gravity, if any, exhibited by particles, if

the specific gravity of the substance be great, and the microscope be set at an angle with the vertical.

Cold I also applied, putting the slides with their cover-glasses in a freezing mixture of broken ice and water, and reducing them to a very low temperature. Still the movements went on as apparently unmodified as ever. Herr Exner says, it will be remembered, that glycerin, which under ordinary conditions shows absolutely none, or almost no molecular movement, shows it clearly when warmed up to the temperature of fifty degrees centigrade. In all the finely divided bodies, however, which I examined, there seemed to be no increase or diminution in the intensity of the movements, corresponding with their alternate subjection to heat and cold. There were occasions in which I thought that I observed acceleration from light, but I always ended by imputing it to the force of imagination, and if it were not justly ascribable to that cause, the fact that it could be so ascribed, is proof positive that if, through the influence of light and heat, any intensification of the movements of the particles took place, it must have been very small. Moreover, the evidence is certainly here, to show that even if the movement were intensified by light or heat, that was the only influence that could be ascribed to them, that light and heat could not be deemed the cause of the movement. And lastly, Herr Wiener's micrometric measurements of the range of movement at different temperatures completely bore out this conclusion.

The theory of Herr Wiener, that the movements are due to the action of the red-wave of light and heat is refuted by the single fact that, as I have proved by experiment, one may interpose at pleasure between the source of light or heat and the particles, either a violet glass or a red glass, without being able to observe the slightest alteration in the movements, either as to their range or their velocity. That is to say, red rays may be either partially excluded or selectively admitted, without diminishing or increasing the liveliness of movement. Hence light can have nothing to do with the phenomenon under discussion, and I have just shown, through the citation of the freezing mixture experiment, that heat can have nothing to do with it.

I have reserved to the very last the discussion of the question as to whether or not the shock, if any there be, from evaporation can have anything to do with the movements, although this was a point that entered into my first investigations. I have reserved it to the

last, because its discussion requires more than the brief space which I have devoted to the previous individual results, and because it leads directly to the conclusion that I have finally reached as to the true cause of the movements. I started out with the conception, which it seems is common to every one, that evaporation might be accompanied with a series of minute explosions, which produce shocks that manifest themselves through the mass of an aqueous solution, in the form of minute movements of finely divided matter held in unstable equilibrium by suspension in the fluid, and that these, escaping cognizance from any ordinary observation, might be visible as such, or in their effects, through the instrumentality of high powers of the microscope. I had come to believe long before, from observation and experiment, that no tremors from mechanical agency or any other, except perhaps from evaporation, could produce the peculiar movements known as brownian, and finally it remained to discover if this or any other intrinsic cause were at work that would account for them.

At this point I encountered an obstacle. My high powers of the microscope were both water-immersion lenses. It seemed, therefore, that even when I had had the drop of liquid under observation, sealed beneath a cover-glass, I might have included, by the use of the water-immersion lens itself, an evaporating surface which might have produced the optical illusion of the movement of the particles in suspension. I proceeded, however, with my experiments, upon the assumption that this, as the event proved to be the case, was not true, and meanwhile procured from Vienna a one-fifteenth dry-lens by Reichert, the highest power of dry-lens that he makes.

I had already obtained for high-power lenses a film of liquid thin enough to be observed through all its strata, free of air within the cell, and protected from evaporation by being hermetically sealed. Any ordinary manufactured cell is too deep, and with all precautions taken contains a little air. On the other hand, the mere cover-glass superposed on a glass slide contains too slight a depth of fluid. I made a cell by using gum-shellac traced in a circlet on a glass slide, which cell, when partially dried, is filled to the brim with the liquid to be observed upon, whereupon the cover-glass is pressed into the yielding gum, thereby expressing the contained air with the superfluous liquid, when the product, dried over night, is fit for use on the following evening. One slide, prepared in this manner and filled with a slightly tinted solution of carmine

from cochineal, had been observed upon by me for weeks, with a one-tenth water-immersion lens, and afterwards, upon the arrival of the one-fifteenth dry-lens, was observed upon without showing any variation in the range and vividness of movement of the particles subjected to examination. I have even covered the whole microscope with a pall of thick, black, woolen cloth, so that not a ray of light could enter it, either through the cover-glass or the eye-piece, and then carefully placing the eye close to the eye-piece, have suddenly thrown light upon the cover-glass, when the brownian movement among the particles was perceived in as active play as ever. I have therefore concluded, from all these experiments, that neither heat nor light, nor electricity, nor magnetism, nor mechanical shock, nor finally evaporation, is operative in producing the movements; in a word, that the particles move uninfluenced by these forces. I am therefore constrained to believe, upon the basis of the information that I have obtained in the manner described, that it is not the particles which are moved by their own energy, or moved by any energy directly imparted to them from outside sources, but that it is the fluid that moves them.

If their own energy moves the particles, we should see them at the same time obedient also to the law of gravitation among themselves, manifested as the resultant of whatever forces are in play, whereas, although they must be obedient to the law of gravitation among themselves, its effects, and generally, as well, those of terrestrial gravity, are so masked as not to be at all perceptible. Now, when we consider how minute all of these particles are, and yet that they move apparently unhindered with such constancy and force, it ought to be apparent, I should think, that they have no self-motive power. However erratic the paths of individual particles may be, the likeness among the movements is extraordinary, so almost identical in every case, varying in greatness of range and rapidity only in inverse ratio to the size of the particle, that we cannot conceive of self-actuated particles so behaving; for relative greatness of size in self-actuated particles ought to coincide with relatively greater, not relatively less, energy of movement; whereas, here the case is reversed. But there are other facts that I have observed through experiment, which also prove what I say. In alcohol, and as far as my experiments go, in fixed and volatile oils, the brownian movements are not observable, and yet the microscope plainly reveals that the movements of foreign bodies in all

these is as free as in aqueous solutions, and I think more so. So molecular movements of solid particles in suspension in aqueous fluids must take place perforce of the constant repulsions of the constituent molecules of the particular liquid present—water. The minute drops of oils supernatant on water, some of them no larger than the particles in the water below, observed by Dr. Brown, as he says, to be almost or wholly motionless, so behave because the molecules of water glide by the molecules of a substance for which they have not even the affinity that would compass opposition. Be the globules of oil on water never so small or large, the molecules of the aqueous fluid glide by them. Whether a small or a large globule of oil be the particle itself on water, there is no movement of the particle. Dr. Brown says none, or almost none. I think that he was mistaken, that there is no molecular movement whatever.

Fixed oils have not the same molecular constitution as volatile oils, nor these the same as alcohol, nor either the same as water. Whatever these differences may signify in various behaviors, under varying conditions, one, among the rest, distinguishes water from the rest and all other liquids. Despite its apparent perfect fluidity, the reluctance of its molecules to move among themselves as smoothly as do those of other liquids among themselves is one of its most evident characteristics. We see this exemplified by the way, long since ably demonstrated, in which a wave is built up from ripples, by the way in which the surf breaks along the shore, and in the ease with which a small proportion of oil in contact with water modifies or subdues its energy. Only recently I steered a boat in Boston harbor between two headlands, between which, and far beyond, white-caps covered the surface of the water, surrounding a placid lakelet of a square mile in area, black by contrast to its white-capped margin, over the surface of which lakelet I was soon smoothly gliding; and this change from turbulent to placid waters was wholly due to the merest film of oil from Boston's great sewer discharging its contents three miles away on the lowering tide from the head-house on Moon Island into the current running towards the sea. I am aware, of course, that part of the calmness described was owing to the fact that the oil lessened the friction of the wind on the water. But that was not the only cause of the calming effect produced by the oil. Oil prevents the friction of parts on the surface of water already in agitation, and thereby quiets the wave already risen. The area which I have just described as a

smooth lakelet had been only a short time before my arrival at the place in precisely the same state of agitation as the surrounding waters. The surface is the part where the wave begins to form, and where it receives constant increments, the wind propagating these, and by impact on the growing wave or billow as a whole, forming and propelling it as a mass, despite its tendency in deep water to oscillate freely in the vertical without translation horizontally. It is easily conceivable that, although particles of oil may, as I have stated, experience no sensible friction when in contact with the molecular movements of water, so almost infinitesimal are they in range, yet that oil forming a film over a large surface of water may, through friction, as an enclosing sheath, tend to quiet the water, and thus impair and gradually destroy its ability to continue the massed effect known as a wave, at the place, the surface, where not only is it generated, but where it most effectively tends to preserve its energy of movement.

Thus, it is not only through its weight that water, when set in active motion, becomes so formidable as we know it to be when in angry mood. It is because, besides the momentum with which it can be endowed through its great weight, it lends itself, through its molecular constitution, to the storage of enormous energy and to the yielding up of that energy reluctantly. Assuming the existence of a sea of oil or one of alcohol, and either in a state of turbulence, and moreover eliminating in imagination the difference in weight between these and water, either in comparison with water equally turbulent would gently come to rest.

The difference between Herr Wiener's view and mine is radical. He speaks of the motion common to fluids as the cause of the brownian movements. But such motion, at least as perceptible through the microscope, does not exist, except in water or in some other liquid in which water is, as I have proved by experiment, a considerable constituent. Then Herr Wiener, although accounting for the brownian movements by hypothetical movements common to all fluids, really makes their causation the vibratory effect of rays of light and heat, to which, he thinks, fluids through their constitution lend themselves. I, on the contrary, show that the molecular motion, called brownian, taking place under all conditions imposable, is a property of water and of water only, and that light and heat have naught to do with producing it, although, as I have admitted, they may possibly act in intensifying it. All that I may

claim to have detected is a phenomenon which reverts to the molecular constitution of water, as to which the moving, solid particles in it concerned in the brownian movement have no more to do than has a current-metre to do with the flow of the stream the swiftness of which it measures. We do not deny that a gas may be essentially pure, and therefore homogeneous, a chemical as well as physical entity, and that, nevertheless, its molecules may have repulsions among themselves: on the contrary, we affirm it. Similarly water, recognized, as it is, as a chemical condition, not a mechanical mixture, has, as here demonstrated, repulsions among its molecules.

When I take into account all that I have detailed, and remember also that these moving particles of which we have been speaking, hermetically sealed under glass, as I have them now under cover-glasses, move indefinitely in time, unmodified in range and velocity, through changes of temperature, through light and darkness, through electricity and magnetism, in the presence of every force to which I have been able to subject them, I cannot but think, when I add that these movements are active in proportion to the fineness of subdivision of the particles, that they are caused by the mutual repulsions of the molecules of aqueous fluids. Did I see a relatively large mass moving as vigorously as the most minute one visible to the eye, I should regard this theory as untenable from that single fact alone, because it would be impossible that molecular action should concentrate effect on a relatively great mass; but when I see, as I do, the largest masses remaining unmoved, and descending in the scale, smaller ones, showing the effects of a faint impulse, and descending further still, others exhibiting sluggish movement, until the sight reaches the smallest particle visible, finding in that the most eccentric and vehement movement of any exhibited, I know then that I am looking at a sea where the little waves dash in vain on the impressionless rocks, barely disturb the floating ships and hulks, but twist and swirl and make frantically dance the little cockle-shells of boats wherever they may happen to be upon the surface; and that, in fine, I am witnessing the molecular movement of this sea in its effort to escape into space. The aqueous fluids, finding no release, as under my cover-glasses, the movements would go on forever; finding it in freedom from confinement, they go on until the fluid which is the condition of their manifestation is in a few minutes dissipated in evaporation.

Thomas Mutter Cleeman.

I must confess that, although every conclusion reached through labor bestowed gives a certain pleasure in legitimate appetite for knowledge gratified, yet this is so far beneath what I had thought might lie hidden under the mystery of the brownian movements, I experience a sense of disappointment. I had thought that this investigation might be one of the paths that lead to the solution of the question whether or not energy is immanent in matter or a thing apart from it. For many years after the beginning of this century nothing fundamental in physics was known beyond the fact that matter is indestructible. It has been learned since, but no longer ago than about fifty years, that energy also is indestructible. It still remains perhaps to be shown that energy is but an emanation and manifestation of matter, reacting on it. Advanced as our knowledge is within a few years as to molecular movement, I had hoped that the investigation of the brownian movements might yield some contribution to molecular theory, and thence lead to a profounder knowledge than we now possess of molecular behavior in the abstract. I am able, however, to claim for the demonstration here no more than that the brownian movements are not the self-movements of finely divided particles in suspension in aqueous solutions, which Herr Wiener had also ascertained, but simply that which he did not ascertain, movements generated by the molecular action of aqueous fluids, instead of being, as he and Herr Exner also thought, in differing form, phenomena due to light and heat. Perhaps even this moderate conclusion may be disputed, but it remains to be disproved.

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## *Obituary Notice of Thomas Mutter Cleeman.*

*By Frederick Prime.*

*(Read before the American Philosophical Society, April 6, 1894.)*

In the year just past, this Society has been called on to mourn the loss of more than the usual number of its resident members. Of these many were taken in the ripeness of their years with their life's work accomplished; some, however, were still in the full vigor of manhood, with apparently a long career still before them. To the latter class belonged the subject of this sketch.

Thomas Mutter Cleeman was born in Philadelphia, July 31, 1843. In

his youth he attended the school of Mr. Gregory in this city, where he formed many of the warm and close friendships which continued throughout his life. Entering the University of Pennsylvania in his sixteenth year, he graduated in the class of 1862; and whilst there developed that marked fondness for mathematical studies which clung to him through life. On leaving the University he entered, as a student, the Rensselaer Polytechnic Institute at Troy, N. Y., graduating in 1865. His standing there was a high one, and on graduating he made an address at the Commencement.

His first active work was as Assistant Engineer on the Allegheny Valley Railroad and on the Pennsylvania Railroad, being under Mr. W. H. Wilson, then Chief Engineer, and closely associated in the work of Mr. Joseph M. Wilson.

His intimate friend, Mr. Walton W. Evans, the eminent engineer, well-known for the high order of his work in South America, sent him to Peru in 1871, to supervise the erection of the first viaduct on the Verrugas Railroad. Being attacked with the Verrugas fever soon after his arrival, which lasted for several months, he was unable to work on the bridge. On his recovery he was appointed Division Engineer of the Callao, Lima and Oroya Railroad, where he remained for some years.

On relinquishing his position in 1874 he returned to this country, but was again sent by Mr. Evans to South America in 1876 as Engineer of the Southern Railroad of Chile.

In the interval between his two first visits to South America he was appointed Principal Assistant Engineer of the Main Building of the Centennial Exhibition in Philadelphia. Whilst filling this position he designed the ingenious construction of trusses, forming a central open space, clear of rods, at the junction of the nave and transept of that building.

From 1876 to 1879 he was Assistant Engineer of the Philadelphia Water Department.

In 1880 he was appointed Resident Engineer of the Richmond and Allegheny Railroad in Virginia.

On relinquishing that position he engaged in a general engineering and consulting practice in Philadelphia.

In the winter of 1892–93 he went to Ecuador as Consulting Engineer on the water works at Guyaquil, at the request of his friend, Mr. A. Millet, who was the engineer and contractor. With this as with everything else he undertook, his interest in the success of the undertaking became very great and the exposure he underwent, in consequence, probably cost him his life. His work there was almost completed and he was looking forward to his return in a few days, so as to spend his Christmas with those he loved so tenderly, when he was stricken down with yellow fever. After an illness of about a week he died, on November 16, 1893, a stranger in a strange land far from those who now so deeply mourn his loss.

Mr. Cleeman was elected a member of this Society October 15, 1885.

He was also a member of the American Society of Civil Engineers; of the Rensselaer Society of Engineers, and of the Engineers' Club of Philadelphia, of which he was a Past President.

In 1893 he delivered a course of lectures on railroads at the Rensselaer Polytechnic Institute, in which he conducted the students through the actual surveys and calculations of the work.

In 1880 he published a work on *Railroad Engineers' Practice*, which has gone through several editions.

Mr. Cleeman was a thoroughly experienced engineer, cautious, intelligent and original in his analysis of theoretical problems, as well as in the execution of engineering work. He was careful to first ascertain that any work he undertook was theoretically correct before carrying it out. His grasp of theoretical subjects was so great that it enabled him to choose wise proximate methods. A friendly critic, he was also a keen one, and his views were generally correct. He did not hesitate to express his opinion on all subjects pertaining to his profession, but never insisted on the acceptance of his view by others; nor had he any of that selfish push and conceited manner which so often meets with undeserved success. A refined, cultured, courtly gentleman, he was entirely unselfish, modest and retiring. His first thought was always of others, never of himself. He was the light of a large circle of friends, as well as of his family.

His death has caused a heartfelt sorrow and sense of loss, not only in the family circle where his sweet nature and gentle manners will always be missed, but amongst the large number of warm and sincere friends, who also loved and honored him

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## *The Dynamics of Boxing.*

*By R. Meade Bache.*

(*Read before the American Philosophical Society, May 4, 1894.*)

The fact that a certain statement lately appearing in the daily press obtained circulation proves how great the general ignorance of some simple physical laws still is. This statement was to the effect that Sandow, "the strong man," is able to strike a blow of 3000 pounds, could break an arm with its impact, and intends to study boxing so as to defeat Corbett. A few observations, therefore, as to the fundamental laws connected with the subject of the possible degree of the deployment of muscular force by human beings in the act of striking a blow will not be out of place for

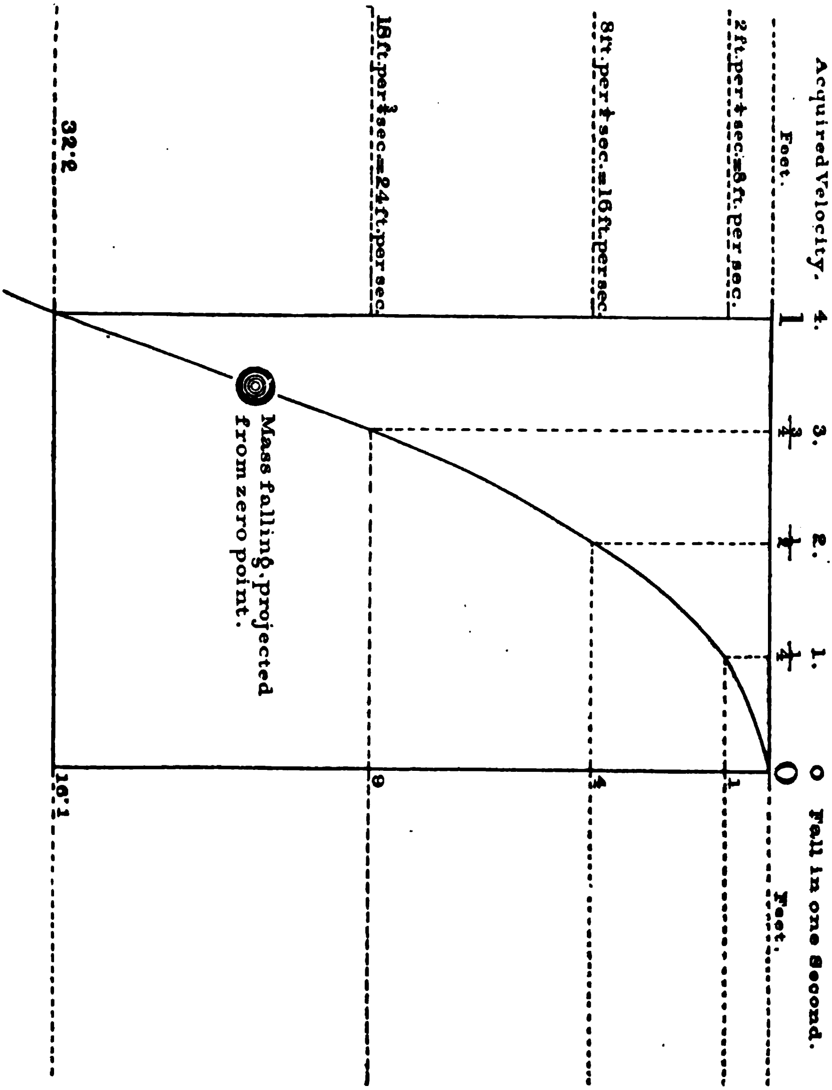
popular instruction. I do not, of course, presume to instruct members of this Society as to these laws, with which they are conversant, but the higher instruction is like head of water, whence the water flows to and filters through lower levels. Besides, beyond the mere restatement here of the laws to which I refer, lies matter with which I think that not even the majority of the members of this Society are conversant. These reasons form, in sum, my explanation for introducing this particular subject to the Society.

The momentum, as you are aware, with which a body, falling freely near the surface of the earth, strikes, varies with the latitude, or otherwise expressed, with the distance of a given place from the centre of the earth, which, owing to the configuration of the earth, corresponds with the latitude. But, for general purposes, and quite sufficiently precise for this, the distance, in the first second, which a free body falls, near the surface of the earth, from a state of rest, is accepted as 16.1 feet, and the velocity which it has acquired by the end of that space and at the termination of that time, as twice 16.1 feet, or 32.2 feet in that second.

The diagram on the blackboard illustrates clearly the effect upon a body moving for one second under the influence of gravity. To understand, then, what follows, it will only be necessary to observe, by referring to the diagram, that the successive spaces traveled by the falling mass represent the squares of intervals, whether of space or time, and also that, although the maximum space traversed in a first second of fall is only 16.1 feet, yet that, correspondingly with the smaller spaces and the inclusive one (all squares of space or time), the acquired velocity doubles continuously, being, instead of 16.1 feet, 32.2 feet in the second, by the time that it has reached the end of the first second of fall. The diagram fully exhibits the law of both relative spaces and relative times concerned in the phenomenon. If the first unit of horizontal space on the diagram, one-fourth, be taken as a unit of time, then its square will represent the value of the corresponding distance of fall. This is 1 foot, with acquired velocity of 8 feet. For successive units of time,—if a mass falls in 1 second, as it does, 16.1 feet, then in 2 seconds it falls 16.1 feet multiplied by 2 squared. It falls in 3 seconds 16.1 feet multiplied by 3 squared, and in 4 seconds 16.1 feet multiplied by 4 squared, and so forth.

Could a soap-bubble move with the velocity of the swiftest cannon-ball, it would injure nothing that it might strike, while the

seemingly almost spent cannon-ball has more than once shorn off human limbs as though they had presented no more obstacle than




thistle-down. Suppose now, that a man weighing 190 pounds (about the maximum weight effective in the ring) should fall, as a

body falling freely near the surface of the earth, for the distance of 16.1 feet. As the moving energy of his mass would be compounded of the mass multiplied by the velocity with which it travels, it would follow that the shock at the end of 16.1 feet (which would take place in a second) would possess the momentum represented by multiplying 190 pounds by 32.2, or 6118 pounds. One, therefore, perceives from the diagram that if, for a weight of 190 pounds, a momentum of only about twice 3000 pounds is generated by gravity in a second, with a velocity *twice as great as a boxer's blow* (as it would be, if the velocity of the boxer's blow at the rate of four feet in a quarter of a second be here correctly rated), it is already demonstrated that a man of 190 pounds could not strike a blow of 3000 pounds, unless he could put his whole weight into it, when, for 4 feet, at the rate indicated, it would be 190 pounds multiplied by 16, or 3040 pounds; and putting his whole weight into it is impossible. But it is worth while to pursue the subject a little further.

Remembering what has just been remarked as to the momentum generated by the fall of a mass of 190 pounds during the first second of time from a state of rest, we must now, in order to make safe comparisons between conditions that are only analogous, not identical, begin by recognizing formally the fact that a man cannot deliver a blow involving the conditions of delivery in a second, over a distance of 16.1 feet, and with an acquired velocity of 32.2 feet. The distance concerned, to say nothing of the other differences, precludes direct comparison between the rate of the man striking and the rate due to gravity. We must therefore institute the comparison and come to a conclusion indirectly. The longest distance over which a tall man can deliver his average blow is about 4 feet. A man with abnormally long reach, like the present boxer, Jackson's, can deliver it over 4.5 feet without changing his footing. If a man delivers it 4 feet in a quarter of a second (and this I think from observation the best boxer can do), he delivers it with the velocity with which gravity would have affected any mass in the first second of time from a state of rest, that is, with a velocity of 8 feet for the half second, or 16 feet per second.

If a boxer strikes four feet in a quarter of a second, of course he strikes at the rate of 8 feet in half a second, that is to say, he strikes with the same velocity as that due to acceleration from gravity during half a second. There is, however, in this case, no ques-

tion of acquired velocity, or what is otherwise known as acceleration, due to terrestrial gravity. I am merely putting the two equals, as derived from different sources of power, in juxtaposition, so as to compare and contrast them with each other, and thus to bring clearly before the mind that it is not likely that any boxer's blow can have a speed essentially greater than that represented by the acceleration due to gravity in half a second, or, in other words, the rate of 16 feet per second. Terrestrial gravity would, as indicated, have nothing to do with the force of the resultant blow. The blow being horizontal, the force of gravity with relation to it would be virtually *nil.* The statement here is limited strictly to the fact that if the boxer can strike 4 feet in a quarter of a second, he can strike that distance with the momentum that would be generated by gravity in one-half of a second, acting on any mass subjected to it from a state of rest.

The fact must be kept constantly in view that mass and velocity combined make momentum. With enormous weight and great slowness, the effect produced is not of the nature of a blow, but that of a push. With great velocity and minute weight, the blow produced is slight. With both great weight and great velocity, the blow becomes tremendous. Here it is well to add that the popular notion of the amount of his weight that a man can put into a push or a blow is highly erroneous. Mechanical engineers, who are continually obliged to make computations for the deployment of the force of pushing on capstan-bars for drawbridges and other places, know that, unless there are cleats on the ground from which the feet can obtain some purchase, from 15 to 20 pounds is about the proper amount to allow for the push of a man working under those conditions. The question therefore remains open in every individual case, unless instrumentally settled, as to what proportion of the mass of the boxer of 190 pounds enters into his blow, and this, with different men, varies as well as the speed. But supposing, for the sake of argument and demonstration, what has already been rejected, that the whole weight of the man enters into the blow, its momentum for 4 feet, at the rate indicated, would be represented by 190 pounds multiplied by 16, or the rate of speed, at the half-second point, due to the force of gravity for a first second, and would be, as already noted, 3040 pounds. A man cannot, however, as already stated, put his whole mass into a blow, because he cannot, by any muscular effort whatsoever, move freely in space. The indispen-

sable condition of his being able to deliver an effective blow is that he shall be, as to his feet, poised on the surface of the earth. So unless, by means of electrical recording apparatus, we determine the speed of a blow, and, by means of a dynamometer, determine the moving energy of it, and deduct one value from the other, we cannot ascertain how much of the effectiveness of a blow is owing to the weight of the human body thrown into it, and how much is derived from a speed which involves the whole person—hand, arm, and trunk.

It would follow, from all the evidence at my command, that if the speed of a blow of four feet be a quarter of a second, a man of even 190 pounds in weight cannot follow up, so as to make effective in his blow, with more than 32 pounds (in round numbers, a sixth of his weight) with velocity equal to free movement of fall of a mass for the first half-second, from a state of rest, above the surface of the earth. Barrett, the late well-known teacher of boxing in Philadelphia, a man of undoubted veracity, as highly esteemed in his day and limited sphere as was, at the beginning of this century, in a more extended one, Gentleman Jackson, of England, Byron's boxing master, once told me as remarkable that he knew a man who could strike 500 pounds. This meant, of course, as tested by a dynamometer. If then, in fine, the time of a boxer's blow be a quarter of a second, the length 4 feet (which would make, as already remarked, the rate the same as that due to the effect of gravity on a mass in the first half second, fallen from a state of rest), and the proportion of his weight accompanying it be 32 pounds, he would strike with the momentum represented by 32 pounds multiplied by 16, or 512 pounds. This momentum, if the reader experienced in boxing will consider the speed here ascribed to the blow of the finest boxer, and the confirmatory evidence derived from the statement of Barrett, would seem to be very near the mark. No one will be likely to maintain, after what has been said, the possibility of striking an effective blow of 4 feet in length in less than a quarter of a second; or that, of the weight of a man of 190 pounds, more than 32 of them can be put into a blow corresponding with the rate of 16 feet per second.

Up to the point we have reached the conclusions drawn were partly dependent upon an estimated velocity of blow, derived from observation, not experiment. But a friend having reminded me that, among Mr. Muybridge's series of photographs of movements of man and

the lower animals is one illustrating the speed of a blow, the examination of it which has followed has led to a remarkable confirmation of the preceding estimate of speed. Plate No. 333 of the Muybridge series represents the phases of a knockdown blow, including the effects, until the person struck is prone on his back on a mattress. The intervals between the photographic phases is ninety-six one-thousandths of a second. Three successive phase-pictures, thus virtually taken one-tenth of a second apart, represent the blow from start to finish. In the first, the striking arm is drawn back and starting from its point of departure. In the second, the arm is seen projecting about half way between the boxing opponents. In the third and last phase of the blow the fist of the striker lands on his opponent. The interval between the first and second phase having been virtually one-tenth of a second, and that between the second and third also one-tenth of a second, the blow was therefore delivered in virtually one-fifth of a second. Measurements on the pictures giving the successive phases show that the length of the blow from start to finish was 38 inches. Here we have the rate of 38 inches in one-fifth of a second. We have previously used the estimated rate of 48 inches in one-fourth of a second. The data derived, on the one hand, from observation, and that, on the other, from experiment, coincide within a small fraction—within half an inch.

It is open to observation that boxers who make their living by ring-fighting carefully conceal from the public, knowledge of the momentum with which they can strike, although this could be easily and safely obtained, and probably often is, with the glove and dynamometer. In the ring, as in many other instances in which all seems physical to the casual observer, moral elements enter. The dangerousness of the man whose exact moving energy of blow is known, is to a certain extent discounted, so potent is the imagination in the affairs of men. Professional fighters know, as well as every one else does, that everything unknown seems magnificent.

The element of quickness in a boxer, in addition to courage, skill, strength, weight, and endurance is indispensable. In the case of such men as Sandow, muscles have been trained by work so ponderous that they do not respond to the will for elastic, quick movements. Men like him cannot put the same speed into their blows as can men trained as Corbett has been, nor can they put the weight of their bodies as effectively into their blows as men can who have

been trained for strong, lithe movements. Consequently, the blows of such men, no matter how heavy the men are, have less power than those of men trained as boxers. So far from Sandow's being able in the ring with Corbett to break his arm or otherwise disable him, he would probably not hit Corbett a single blow, or if he did, not one that would have the effectiveness of his opponent's, because it would lack the speed and accompanying weight thrown into his by a boxer endowed with a rare combination of height, strength, weight, and reach, supplemented by agility marvelous for a large man, trained by life-practice to highest excellence within his sphere, and all crowned by the habits which promote endurance.

We should rejoice that we live in an age remote from the false sentiment of some former times, an age of revived physical culture, when it is possible to bestow undisguised admiration on physical excellence of any kind, in its sphere as fine as moral worth, of which it is in some subtle way even now partially emblematical, to become, mayhap, in the course of time, through more general observance of the laws of nature, wholly identified with it, and indivisible in attributes. Within our own time is observable a great advance in obedience to those laws. It should be evident that the almost universal admiration for physical development and prowess is not wholly derived from the combative quality of mankind, but has its root deeper in human nature, in the general interest in the health and welfare of the species. If, however, it be needed that the combative manifestation of nature be sustained on moral grounds, then is its defense easy. Inasmuch as the present stage of development is conditioned in almost every sphere of animal life on self-defense, self-preservation being still the first law of nature, all teachings which tend to suppress among men any resort to the *ultima ratio* of their kind, tend also to transform their means of defense exclusively into the meaner modes of securing it, into the adoption, to that inevitable end, of cunning and treachery, and the swarm of the meaner vices, sapping the noble elements of their nature, which must go hand and hand and stand or fall together. For my own part, I candidly avow that my observation of life from boyhood onward, derived from personal experience, from history, and from noting racial tendencies in the present era, has led me to believe that, with reprobation and repression of physical force, as potential, and therefore, if need arise, actual, in matter for which law offers no protection, nor ever will or can, must inevitably go various un-

George de Benneville Keim.

derhandedness in the conduct of life. I firmly believe that those nations which cultivate physical development by countenancing and promoting athletic sports and contests, with due regard to the exclusion of the cowardliness of brutality, will ever possess in their citizens, as compared with those of other nations differently prompted through race, or differently controlled by law or dominant public sentiment, a greater proportion than the others of those inspired by independence of character, honor, and disposition to fairness as between man and man, constituting them relatively the more stalwart lovers and defenders of the right in every form.

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## *Obituary Notice of George de Benneville Keim.*

*By D. G. Brinton, M.D.*

(*Read before the American Philosophical Society, May 4, 1894.*)

Those who have had a reasonably long and intimate knowledge of men must have observed that among the individuals prominent in the active affairs of the day there are two classes—the one, of such as are wholly absorbed in their daily pursuits, whose natures are, to use a simile of Shakespeare's, "subdued to what they work in, like the dyer's hands"—the other, who, however compulsive and harassing their avocations, retain an individual and independent freshness of personality, often strangely in contrast with the requirements of their working hours.

Distinctly to the latter class belonged our late member, George de Benneville Keim; and all who enjoyed his friendship will agree that an appreciation of his career would be imperfect which failed to present these two aspects of his character. I shall begin with that in which he was familiar to the world in general, and then I shall say a few words about him, as he was known to his friends and near associates.

Mr. Keim was a descendant in the sixth generation of Johann Keim, a member of the Society of Friends, who emigrated from the Rhenish Palatinate to the colony of Penn, and settled at Oley, Berks county, in 1704. The grandson of this Quaker emigrant was General George de Benneville Keim, an officer of note in the

war of the Revolution, from whom our late member derived his name. The de Bennevilles were a French Huguenot family who joined the settlement at Oley in the early years of the eighteenth century.

His parents were George M. Keim and Julia C. Mayer. At the time of his birth, the date of which was December 10, 1831, they resided in Reading, Pa. There he received his preliminary education, and later was at school in Georgetown, District of Columbia. At an early age he matriculated at Dickinson College, Carlisle, Pa., where he graduated in 1849, when eighteen years old.

His first intention was to prepare himself as a mining engineer, and with that object in view he removed to Philadelphia and entered the laboratory of Dr. Charles M. Wetherill, where he engaged in the study of chemistry with especial reference to assaying and mineralogical analysis.

Soon, however, his predilection for a more strictly professional life asserted itself, and in the following year, 1850, he returned to Reading, and began reading law in the office of Charles Davis. Two years later he was admitted to the bar, and began practice in the same city.

At that time, the titles to many of the anthracite coal-bearing tracts in Eastern Pennsylvania were by no means clear, and costly and protracted litigation about them occupied the attention of the courts. To these intricate questions Mr. Keim early devoted himself, and rapidly acquired a remarkable familiarity with their confusing details. This special knowledge brought him into contact with many prominent owners and operators, and at the suggestion of some of these he transferred his office to Pottsville, Pa., in the year 1855.

Here he formed a friendship which lasted for many years and materially influenced his after-life. It was with Mr. Franklin B. Gowen, who about that time began the practice of his profession at the Schuylkill county bar. They were closely associated in many important cases, and Mr. Keim's intimate knowledge of most of the valuable titles in the anthracite coal basin soon obtained for him a large and remunerative practice.

When the Presidency of the Philadelphia & Reading Railroad Company became vacant through the resignation of Mr. Charles E. Smith, at the request of the Board of Directors Mr. Gowen provisionally accepted the position. His remarkable abilities, forci-

ble character and brilliant oratory commanded the admiration of all who met him, and it was not long before he was elected definitely President of this important outlet of the anthracite region. His far-reaching plans were soon formulated, and under the name of the Reading Coal and Iron Company a gigantic corporation was created, the object of which was to control, by purchase or lease, practically the whole product of the western, middle and southern anthracite coal fields.

The crucial part of this colossal undertaking—the examination of the numerous and complicated titles—was entrusted to Mr. Keim. The thoroughness with which he performed this herculean task has excited the astonishment and admiration of members of the bar ever since, for although the transfers which he passed covered about ninety thousand acres and involved many millions of dollars, not one acre has been found, the title to which he approved, but that title has, in every instance, been confirmed by the courts in spite of sometimes strenuous litigation. It is doubtful if any other real estate lawyer in the State can approach such a record, either for magnitude of transaction or uniform accuracy of opinion.

These occupations brought him constantly into relation with the affairs of the Reading Railroad and in 1871 he was appointed its General Solicitor. The calls upon his time at the central office became so frequent that, in 1874, he left Pottsville and took up his residence in Philadelphia, which city became his home for the remainder of his life.

The severe depression in business throughout the country which followed the famous crash of 1873 soon made itself felt acutely on the extensive and heavily hypothecated interests of the Reading Railroad and the Coal and Iron Company. Affairs drifted from bad to worse until, in May, 1880, both companies passed into a receivership. Mr. Keim was appointed, *pro tempore*, to that office. This threw an enormous burden of complicated and discouraging business upon him. In this position he continued until January, 1884, when a reconstruction was arranged and Mr. Keim assumed the Presidency of both companies. This phase lasted but a short time, and in June of the same year both companies again passed into the hands of receivers, of whom Mr. Keim was one, and in that condition they remained until January, 1888.

During this trying period Mr. Keim made every effort to sustain the financial integrity of the companies, to guard their disburse-

ments, and to protect the interest of those whose investments were in them. He steadily resisted the pressure brought to bear upon him to authorize foreclosure proceedings, and what was to him probably the most painful of all the sacrifices he was called upon to make, rather than violate his sense of duty to those who had entrusted him with this great responsibility, he renounced the ties of long and closest friendship.

This receivership ended at the beginning of 1888, when Mr. McLeod was elected President of the Reading Railroad and Mr. Keim of the Reading Coal and Iron Company, and a member of the Board of Managers of the Reading Railroad Company. He resigned from both these positions some time before his death, but up to that event was a Director of the Baltimore and Ohio Railroad Company.

Some idea of the magnitude of the business which devolved upon him during his second receivership may be derived from the official statement, that in that period the gross earnings of the companies were about $150,000,000.

For some years before his decease Mr. Keim had been subject to periodical attacks of arthritic disease, which had doubtless left their impress on the arterial walls and predisposed him to apoplectic seizures. He had visited Europe several times in order to avail himself of the benefits of some of the health resorts recommended for such cases. On Saturday, December 16, 1893, while engaged in some business transactions, he was suddenly seized with vertigo and allied symptoms. He was conveyed to his home and prompt aid was summoned, but in vain. The attack was rapidly progressive, and terminated fatally on the morning of Monday, December 18.

In spite of the absorbing nature of his professional duties, Mr. Keim found leisure to read extensively in general literature and to take a broad and real interest in the progress of thought and culture. The history of his native State and country possessed an early and lasting attraction for him. He was elected a member of the Historical Society of Pennsylvania, December 12, 1853, and was chosen Vice-President, May 1, 1876, to which office he was continuously reëlected up to the time of his death. He was Trustee of the endowment fund, to which he was also a liberal contributor, as he was likewise to the other needs of the Society. Though a regular and interested attendant at the meetings, he was not a writer for the Society's publications.

When the Governor of Pennsylvania was requested by the Legislature to appoint a Commission who should select two distinguished Pennsylvanians as subjects of statues to be presented by the State, and placed in the Capitol in Washington, Mr. Keim was one of those entrusted with this delicate decision. The two decided upon were General Peter Muhlenberg and Robert Fulton, and this selection met with the general approval of the people of the State.

Mr. Keim was elected a member of the American Philosophical Society, April 21, 1882. He was frequently present at its meetings, and manifested an active interest in all questions touching its welfare, as well as in many of those of a scientific character brought before its sessions.

Throughout his life he was a lover of books, especially those relating to history and classical English literature. His library was large, and displayed sound judgment and good taste in the selection of its contents. In it, he often sought and always found a welcome relief from the harassing routine of his daily duties.

Professionally, his strength lay in his profound acquaintance with real-estate law and his accurate estimate of the bearings of precedents. He was not a jury lawyer, and he always felt a hesitation in addressing an audience. Although remarkably able in drawing up a lucid and convincing statement, whether in matters of business or purely technical, a certain timidity of temperament prevented him from becoming an orator. In this he was in singular contrast to his partner, Mr. Gowen.

The ennobling inspirations of domestic life were deeply appreciated by Mr. Keim. In early life he married Miss Elizabeth C. Trezevant, only daughter of Dr. Louis C. Trezevant, of South Carolina. His widow and two daughters survived him.

In the calm pleasures of the home circle he delighted to pass the hours when business calls ceased their demands. For this reason, he was less frequently an attendant at public receptions and entertainments than many of his fellow-citizens holding similarly prominent positions.

Throughout his extremely active life and his constant dealing with questions of magnitude and difficulty, Mr. Keim retained the unvarying respect and generally the warm affection of those with whom he was thrown in contact. His characteristics were entire honesty and sincerity, a simplicity of manner which led him to treat all,

no matter what their station in life, with equal courtesy, and a clear, sound judgment, which guarded him from the imposition of the fraudulent or the flattery of the interested. To use the expression of one who knew him long and well, Mr. Charlemagne Tower, Jr., "the leading traits of his private character were honor and loyalty." His charities were unostentatious, but large and constant. One of his old friends writes me that he personally knows of several whom Mr. Keim regularly assisted, and who depended on this assistance for much of the comfort of their lives.

While his acquaintances were numbered by thousands, his intimates were few. Although affable and ready of access, it was not at all easy to understand his real nature, nor to approach his inner personality. A peculiar dry humor, an odd candor of expression, foiled the importunate and disarmed the aggressive. Under the appearance of a certain levity of language and manner he baffled those who attempted to transgress the lines which he had drawn around his intimate life. The impression thus created was so different from that usually expected from a man bearing such heavy burdens of responsibility, that it always at first puzzled, if it did not even disappoint, those who knew him but slightly. Behind this outward habit of encounter, however, was a keen, penetrating judgment and a warm, sympathetic nature, fully recognized and appreciated by those who understood the thoroughness of his work and the spirit of his actions. By his death our city lost a distinguished and worthy citizen, his friends one always dear to them, and this Society an estimable and interested member.

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## *Some New Red Horizons.*

*By Benjamin Smith Lyman.*

*(Read before the American Philosophical Society, May 18, 1894.)*

It seems to be worth while to give, at least roughly and in part conjecturally, some idea of the relative geological position of the different horizons from which fossils have been reported in the so-called American New Red of the eastern part of the United States; for it will thereby be seen how completely and naturally the recently discovered, unexpectedly great, and consequently perhaps not readily accepted, thickness of the New Red in Montgomery county, Pa., harmonizes with all the hitherto

publicly recorded facts in other States. It is true the imperfection of the records will make the present attempt somewhat conjectural, but there is reason to hope that it may keep well within the not wholly unprecedented New Red proportions of two bushels of conjectures to two grains of fully ascertained facts.

Indeed, a great share of what has been voluminously written about the New Red is a mere tissue of conjectures, one part depending on another; but if their connection be traced from one to another it will be clear that the starting-point or original support of them all is the supposed fact superficially and inaccurately observed, and in any case not necessarily conclusive, that the beds in question were at the outset wholly, or almost wholly, of a red color. To be sure, dark-colored beds were seen here and there, but were supposed to have become so by the baking of neighboring exposed or subterranean trap. They were sometimes called "indurated shales," though miles away from any visible trap, and their existence above trap beds, even at some distance, was considered by the most skeptical to be sufficient proof of the intrusive character of the trap.

The next conjecture was that as the beds were all red, or originally so, they must be of one narrow paleontological period, a conjecture favored by the circumstance that fossils were not very numerous, and in fact, as we shall presently see, were confined in great measure to a very limited portion of the whole series. They were all referred indiscriminately to the series merely as a whole, and any diversity of character was overlooked or violently disregarded, and they were by circular reasoning pronounced incapable of belonging to species foreign to that small period. Then it was conjectured that during one narrow paleontological period no very enormous thickness of beds could possibly have accumulated, not more than, say, 3000 or 5000 feet. Then, again, it was conjectured that a series of, at the most, such moderate thickness might well exist in full extent within very small geographical bounds, that in short it was, as has been said of the soul in the human body, "all in every part," and was equally complete in Massachusetts, Connecticut, New Jersey, Pennsylvania and in the Richmond (Va.) coal field. The result of borings in that field occasioned the conjecture that the whole New Red series was only 1500 feet in thickness, even in Pennsylvania; and there was probably surprise at finding a boring could be 3000 feet deep without reaching the bottom of the series at Northampton, Mass., where an unprejudiced tyro in geometry might have predicted the result as not improbable from the exposed dips. The idea, however, had by frequent repetition become fixed, though in reality a mere conjecture, that the total thickness must be small, and hence came the unhesitating rejection of the apparent thickness of 14,000 feet in New Jersey and 55,000 feet in Pennsylvania, in spite of their being in truth arrived at by the only means based on published facts then possible, namely, the estimated average dip and the whole geographical breadth of the series. Although, then, the estimates of the total thickness have varied from 1500 to 55,000 feet with some slight support from

observed facts, it has become a heresy to maintain a thickness different from the still more purely conjectural one of between 3000 and 5000 feet.

Then naturally followed conjectures to account with that moderate thickness for so great a geographical breadth in spite of the known dips. These conjectures have been ingenious and elaborately argued and zealously adhered to, but have one by one been disproved or found to be at best only imperfectly supported by observation. It was thought that the dips might be merely apparent or due to false bedding, deposition on a sloping surface, but the thin-leaved, shaly character of some of the beds and the position of the pebbles, ripple marks and fossil footprints have shown the impossibility of that supposition. It was further conjectured that a series of great parallel longitudinal faults with downthrow constantly in one direction might diminish the thickness to the required extent, but their main support was the very insufficient one that recurring hard beds or parallel hills had a similar red color. A careful consideration of the very much curved strike of the beds in some parts of Pennsylvania and New Jersey shows that no series of parallel great faults would help the matter. Besides, although faults of a few feet or yards are numerous, their direction is not generally longitudinal nor the downthrow uniformly in one direction, and but one great fault has yet been proved to exist, and that only in Pennsylvania and New Jersey, and by no means generally longitudinal.

Conjectures in regard to the trap, supposed to be so important in "indurating" and darkening the New Red, have been, if possible, even more wild and needless. The impression seems generally to have been very strong that every mass of trap must be a dike, and that if it was undeniably interbedded conformably with the shales, it must necessarily be a dike that closely followed the bedding intrusively, no matter how many miles, no matter how soft the shales, no matter how gentle the dip. Sometimes it was preposterously suggested that the trap had occasioned the dip of the shales, both near to it and far away. But, in general, as much advantage as possible was taken of the dip, and the trap supposed to be intruded after the dip had been fully acquired, quite dissociating certain sheets of trap from the age of the New Red sedimentary beds with which all the trap is otherwise so closely connected, and not considering that the dip is even now probably still in process of gradual acquirement, or by occasional small fits and starts (witness the earthquake that was felt only the other day between Lambertville and Flemington, N. J., near the line of the great fault there, and corroborative of the existence of the fault at the place pointed out in a former communication, *Proc. Amer. Philos. Soc.*, Vol. xxxi, p. 314). Yet, as the dip alone is so gentle that a dike following it must have come from many miles' distance to have originated at a depth great enough to be melted, and could hardly be supposed to refrain for so long a space from sometimes breaking across the soft shales by a short cut to the surface, it was imagined that the dike must be nearly vertical at a short distance below the outcrop. Then as

the outcrop was sometimes (for example, in the case of the Palisade trap) more than fifty miles long and "as crooked as a ram's horn," the vertical parts of the dike must, by a marvelous coincidence, have followed the same curves. *Credat Judæus Apella, non ego!* Really, such a belief seems to require an amount of credulity hardly consistent with the modern scientific spirit that hesitates to accept extraordinary explanations where ordinary ones can be found to answer the purpose.

The intrusive conjecture has in fact been in great part rejected, but not hitherto for the Palisade trap, owing to certain observed facts. Still, it seems not at all impossible to account for them, so far as recorded, much more easily and naturally than by the well-nigh supernatural intrusive theory. If the trap appears in one place to cross the sedimentary beds on one side, why may it not be either the side of a dike (for, of course, every overflow must come from a dike somewhere) or merely an evidence of the erosion that took place before the trap overflowed; just as in the case of the "horsebacks" or "rock faults" in coal mines, a small valley in the original coal marsh has been filled with sand or silt? If there be here and there a branch from the bottom of the trap sheet running a short distance into the sedimentary beds, is it not as easily conceivable in the case of an overflow as in that of intrusion? Is it wholly inconceivable that apparently similar branches from the upper surface of a trap overflow sheet into the sedimentary beds might sometimes occur, though none are positively recorded? If there be "indurated shales" above some of the Palisade trap, is it not quite possible, in case of real "induration," that there be another overlying unexposed bed of trap that may have caused it, especially as there is other evidence of interbedded shales? The intrusion conjecture is beset with so many serious difficulties, and the overflow theory with so few, the choice between them seems easy. A vast amount of ingenuity has been expended in trying to reconcile observed facts with the intrusive theory, while immensely less skill is required to show the consistency of the facts with the overflow principle.

The New Red theory, with its conjectures and arguments, both for the trap and the sediments, might well be called the tennis ball of American geologists, or a domestic appliance for mental gymnastics, requiring the minimum of work in the field. Nevertheless the fabric, composed, as we have just seen, in the main wholly of conjectures, based one upon another, without having at the bottom one single substantiated fact, has with the lapse of time become so consolidated, and in its older parts, dating from the early infancy of geology in America, has become so venerated that it may now be considered to be a fully "accepted fable." The hand that attempts to disturb it may probably be regarded as sacrilegious; and arguments against it, though thoroughly founded on facts, will be looked on with more suspicion than new conjectures would be if only consonant with the old baseless ones. But however stubbornly skeptical the public may be in refusing to put faith in the present conjectures, well supported by many observations, instead of the old ones, supported only

by other conjectures, there may yet be found some convenience in the present collation of facts.

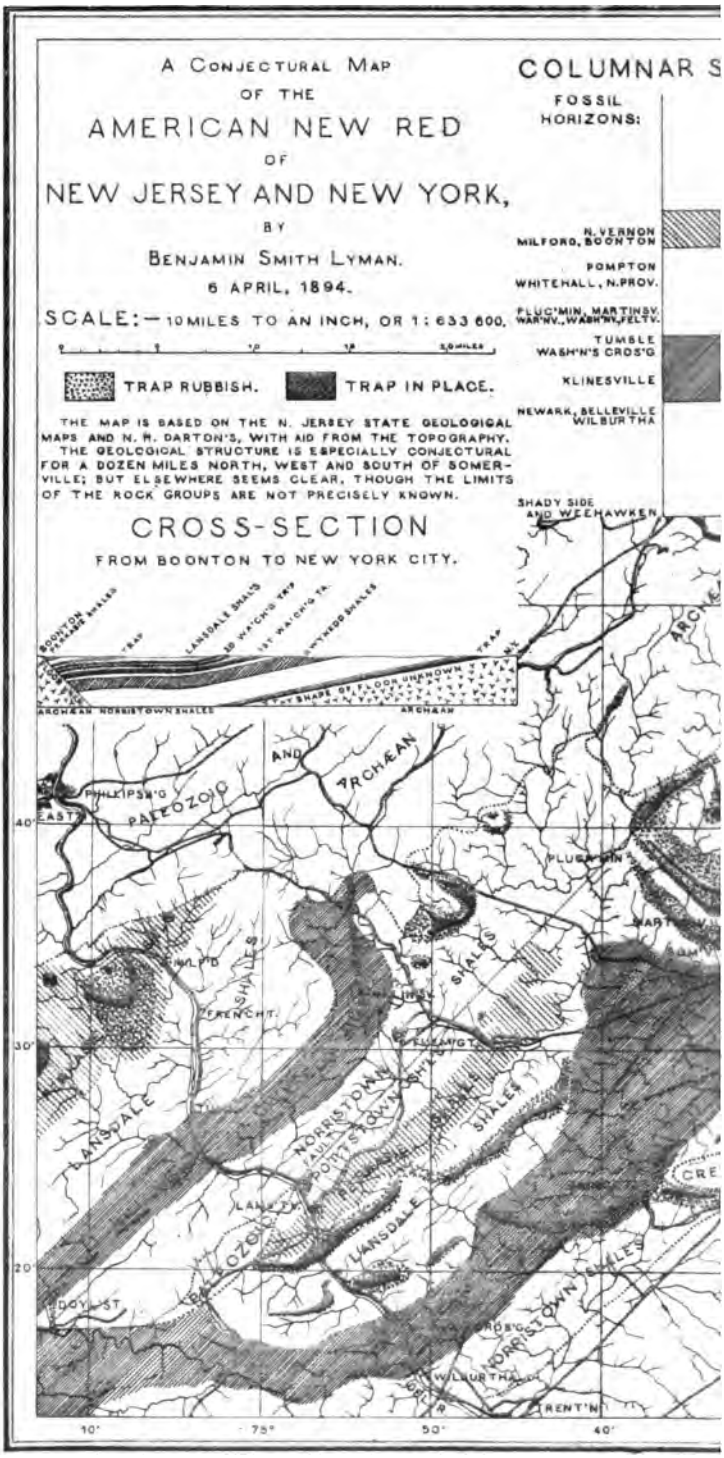
New conjectures are still necessary owing to the imperfection of the record of facts outside of Pennsylvania. Although the New Red stretches for hundreds of miles close past some of the most populous parts of America, the probable economic resources never seemed enough to secure its thorough examination and a publication of the results. Even as regards field work it has been a sort of play-ground for geologists rather than a place for thoroughgoing investigation. The State governments to this day, with all their surveys, have never fully provided the means for such work. What little field work has been done, outside of Pennsylvania, has been, in great part, carried out with the exaggerated idea that the geology of a region can be studied out merely by a comparison of the fossils, a far shorter and easier way than the laborious methods of properly geological observation and collation. Such purely paleontological geologizing may be likened at its very best to the rapid hypsometrical work of the aneroid instead of the spirit level; and exclusive dependence on the fossils for geological indications may be compared with confiding in pocket-aneroid work more than in railroad leveling. Furthermore, the paleontologists have not merely altogether neglected to plot numerous dips as an indication of geological structure, but they have not generally thought it worth while to indicate with any sort of precision the beds that have yielded their fossils; though Fontaine has done something of that kind. Wheatley, alone, gave a measured columnar section of about 180 feet, showing clearly the position of his fossils; but he must have been more a geologist than a paleontologist.

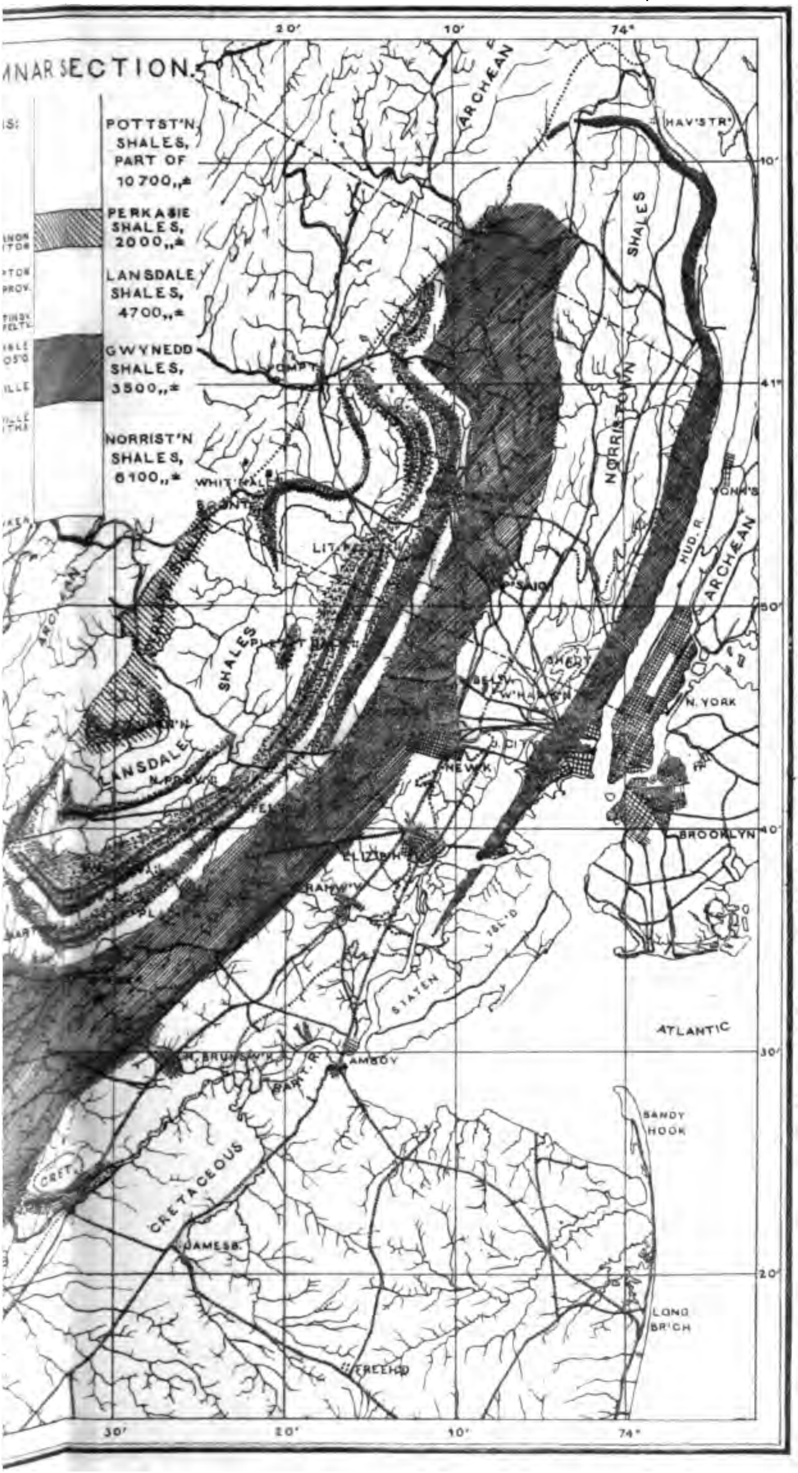
The Pennsylvania foundation of the present conjectures is, however, far from conjectural. We are not here entering upon another system of conjectures based on conjectures, but conjectures based at least on facts; and it is to be hoped that the conjectures themselves may prove to have nothing improbable, violent, unnatural or supernatural in them. The unexpectedly great thickness of the New Red in Montgomery and Bucks counties is not conjectural, but has been ascertained by means of much careful, laborious, time-taking work in the field and in the office. Something like one-half of the field was excellently mapped with ten-foot contour lines by the Philadelphia Water Department several years ago, and the rest was roughly contoured expressly for the New Red investigation, and the completed map of it was in part replaced by some United States geological work just then published. Some two thousand dips were plotted on the map. Some two thousand rock exposures, including all the railroad cuts and many long river-side cliffs, were observed, measured roughly and drawn in columnar section to scale. Besides the written description of each rock-layer, some four thousand rock specimens were taken for a more complete understanding and for comparison one with another. A general columnar section was formed by combining the separate ones, computing the intervals between them, having due regard to the dip,

strike and elevation of each exposure, and proceeding from point to point between the nearest ones, so that no essential error could occur from changes of dip or strike in so small a space, and checking occasionally the computation between two distant points over one route by like computations over another route, with the aid sometimes of a comparison of specimens to identify the beds of one observed section with those of another. The topographical features of the country also aided in working out the structure. A complete publication of all the evidence would have been more costly than perhaps at present desirable, and certainly more so than the funds at hand would permit; but it is hoped that the map and cross-sections just now about to be published will be found to contain enough of the facts to be fully convincing of the substantial accuracy of the results. The map was taken in hand by the lithographer over a year ago, and its publication is now almost daily expected, and may take place before this paper can be printed; so that it is not necessary to give here a map or sections of the Pennsylvania portion of the New Red.

The survey, then, has shown that the so-called New Red in Montgomery county is at least some 27,000 feet thick, and that it may be divided into five parts as follows, from above downwards: shales mostly soft and red, at Pottstown and northeastward, about 10,700 feet thick; shales, in great part hard and green, partly blackish, and dark red, at the Perkasie tunnel and near it, with some small traces of coal, about 2000 feet; shales, mostly soft and red, at Lansdale and near it, about 4700 feet; shales, in great part hard, dark or greenish gray, and blackish, partly dark red, at the Gwynedd and Phœnixville tunnels, with traces of coal, about 3500 feet; shales, mostly soft and red, but in small part dark gray, or green, or blackish, with some beds of brown sandstone and of gray sandstone and pebble rock, at Norristown and eastward, about 6100 feet. That is, in the main, two sets of hard dark shales, with soft red shales above and below each; and the lower set of dark shales thicker, blacker and more carbonaceous than the upper one. Nevertheless, the resemblance of the two sets and the fact that, owing to the great fault, both occur twice near the Delaware have occasioned some confusion. It would probably be fruitless to attempt at present outside of Bucks and Montgomery counties to identify more definite horizons than these five great bodies of rock; and it must still be only with more or less of conjecture that even they can be traced into distant States by the maps and descriptions that have been published.

Even in Pennsylvania, outside of those two counties, the published information is too defective for the purpose. If the State government had ever made possible a topographical survey of the whole field, it might probably be comparatively easy now to trace each subdivision by the help of the topography all the way to the Maryland line. As it is, we can only conjecture roughly the horizons of the fossils that have been found. For example, it is very probable that the vertebrate fossils near Emigs-


A CONJECTURAL MAP
OF THE
AMERICAN NEW RED
OF
NEW JERSEY AND NEW YORK,
BY
BENJAMIN SMITH LYMAN.
6 APRIL, 1894.
SCALE:— 10 MILES TO AN INCH, OR 1 : 633 600.
TRAP RUBBISH.
TRAP IN PLACE.
THE MAP IS BASED ON THE N. JERSEY STATE GEOLOGICAL MAPS AND N. H. DARTON'S, WITH AID FROM THE TOPOGRAPHY. THE GEOLOGICAL STRUCTURE IS ESPECIALLY CONJECTURAL FOR A DOZEN MILES NORTH, WEST AND SOUTH OF SOMERVILLE; BUT ELSEWHERE SEEMS CLEAR, THOUGH THE LIMITS OF THE ROCK GROUPS ARE NOT PRECISELY KNOWN.
CROSS-SECTION
FROM BOONTON TO NEW YORK CITY.
SHAPE OF FLOOR UNKNOWN
ARCHÆAN
NORRISTOWN SHALES
COLUMNAR S
FOSSIL
HORIZONS:
N. VERNON
MILFORD, BOONTON
POMPTON
WHITEHALL, N.PROV.
TUMBLE
WASH'N'S CROS'G
KLINESVILLE
NEWARK, BELLEVILLE
WILBURTHA
SHADY SIDE
AND WEEHAWKEN
PALEOZOIC
AND
ARCHÆAN
PHILLIPSB'G
EASTN
40'
30'
20'
LANSDALE
SHALES
FRENCHT.
FLEM'GT.
NORRISTOWN
POTTSTOWN
LANSDALE
PALEOZOIC
DOYL'ST.
NORRISTOWN
WILBURTHA
TRENT'N
CRE
10'
75°
50'
40'


MNAR SECTION.
POTTST'N SHALES, PART OF 10700,,±
PERKASIE SHALES, 2000,,±
LANSDALE SHALES, 4700,,±
GWYNEDD SHALES, 3500,,±
NORRIST'N SHALES, 6100,,±
20'
10'
74°
10'
41°
50'
40'
30'
20'
30'
ARCHÆAN
HAV'STR'
SHALES
NORRISTOWN
YONK'S
HUD. R.
ARCHÆAN
N. YORK
BROOKLYN
SHALES
LANSDALE
N. PROV'E
N'W'K
ELIZ'H
STATEN
ISL'D
ATLANTIC
AMBOY
SANDY HOOK
CRETACEOUS
CRET.
JAMESB.
LONG BR'CH
FREEHD

The Virginia fossils mentioned by Fontaine, forty-two species of plants, all appear to have occurred within the extreme limits of the coal-bearing beds of the middle member of the Richmond and Farmville basins; that is, within a thickness of about 150 feet, and, beyond a doubt, within what corresponds to the Gwynedd shales.

In North Carolina, the composition of the Mesozoic would seem to be very like what it is in Virginia, with three members in the eastern Deep River coal field and three in the western Dan River coal field, each field with its middle member comparatively blackish or greenish and slatelike, with conglomerates and sandstones below, gray, brown and red, and with similar soft and hard red, brown and mottled sandstones above. The description applies more particularly in the Deep River field, but the rocks of the Dan River field are said to be similar and to consist of the same members (see Emmons as reported in *Macfarlane's Coal Regions of America*, pp. 518–520, 526). Moreover, the geographic position of the two fields would seem to make it highly probable that the Deep River rocks would correspond to those of the Richmond coal basin, and Fontaine considers them to do so. The Dan River beds, however, would seem to correspond with those of the Farmville basin, that is, to be the same beds as the Richmond and Deep River beds, but on the western side of an anticlinal. Both the Deep River coals and the Dan River coals would then belong among the Gwynedd shales. It is true, Emmons later considered the lower part of the Deep River darker member to be unconformable and much older, even Permian, and called it the Chatham series; but Fontaine finds nothing in the fossils to confirm such a suspicion.

The North Carolina fossils mentioned by Emmons all come from the Deep River coal field. Only four of them come from what he calls the bituminous slate group of the Chatham series, beds most closely connected with the coals and corresponding, in Fontaine's opinion, to the beds associated with the Richmond coals, the same probably as the middle member of the Richmond coal basin and a part of the Gwynedd shales. The thirty-six other fossil plants all come from higher up, but from what seems to correspond to the middle or upper part of the Gwynedd shales within, say, at most 2000 feet above the coal beds, and below the thick, "red marly sandstones," that may correspond to the upper part of the Gwynedd shales or to the lower part of the Lansdale shales. The North Carolina fossils then all appear in any case to belong to the Gwynedd shales.

As regards the New Red in New Jersey, it was suggested in the previous communication already referred to that possibly a careful study of the topography as set forth in the valuable maps of the New Jersey State Geological Survey might enable the New Red main subdivisions to be traced quite across the State. Later, on actual trial, it did seem possible to accomplish so much rather satisfactorily, and the accompanying map of the New Jersey and New York New Red gives the result. The geo-

logical structure is nearly everywhere quite clear; only within a semicircle for a dozen miles north, west and south of Somerville the indications are not quite certain, and more thorough field work is especially desirable there. Elsewhere, too, the limits of the different subdivisions cannot be supposed to be very precisely marked. In the main, however, the geological structure given in the map seems unquestionable and unmistakably confirmed by the published dips, by the topography, by the trap sheets and by the perfect correspondence and harmony throughout of one part with another.

It is readily seen from the map and its sections that the fossil horizons of Weehawken and Shadyside belong to the lower part of the Norristown shales, and the horizon of Newark and Belleville to the upper part of the same, as indicated also by the close lithological resemblance of the brown building stone of these places to the stone found in Pennsylvania only at that horizon, particularly at the Yardleyville, Newtown and other quarries. The Wilburtha fossils opposite Yardleyville on the Delaware obviously belong to nearly the same horizon.

The Klinesville fossils come clearly from the Gwynedd shales, apparently a little below their middle, and the fossils found near Washington's Crossing and Tumble Station must be from near the top of the same shales. The fossils of Little Falls, Pleasantdale, Feltville, Washingtonville, the Field Copper Mine near Warrenville ("near Plainfield," of Newberry), are all evidently close to one horizon, and that probably in the Lansdale shales near their bottom. The fossils of Martinsville and Pluckamin are perhaps slightly higher up in the same division; those of Whitehall and New Providence apparently at about one horizon slightly above the middle of that division, and those of Pompton Furnace still higher towards the top of the division. The fossils of Boonton would seem to be of about the same horizon as those of Milford in the Perkasie shales, near the bottom; and those of New Vernon slightly higher in the same shales.

It may be noticed that the map represents the trap in place as generally much less extensive than it is commonly given in New Jersey geological maps. It appears to have been customary, both here and in the Connecticut Valley, to infer the existence of solid trap everywhere beneath the surface exposures of trap bowlders and decomposed trap earth. From observations in Pennsylvania, however, it seems far more probable that the solid trap in place is of much narrower dimensions, as often appears where streams have cut their way through hills. It seems quite natural, too, that so hard a rock as the trap generally is should be left by the erosion in the form of hills, standing out prominently above the neighboring spaces that are underlain by the comparatively unresisting sedimentary rocks, chiefly soft shales. It is also quite natural that abundant remains of broken blocks or bowlders and decomposing earth from the trap, so durable is it, should long exist not only beneath the places where its solid bed once lay, but also be carried by the eroding waters to some little

distance in other directions from the outcrops of the solid undisturbed trap. The surprising thing, indeed, is perhaps that the trap hills are not more prominent in the midst of such soft rocks, and that the trap bowlders and gradually decomposing rubbish should not have accumulated to a still greater extent. The explanation, no doubt, is that the trap, with all its hardness and, in human experience, durability, is yet in geological ages comparatively easy of decomposition. At some places it is obviously decomposed almost to incoherence in large masses yet in place, only made visible by railroad cuts. It has therefore seemed advisable to mark the trap as solid, in place, only where it appears to have occasioned hills of some prominence; and, even so, the true extent may have been exaggerated, particularly, perhaps, in the case of the Palisade trap along the Hudson river, where there may well be concealed important beds of shales between separate sheets of trap.

It will be seen from the map that not all of the trap is in overflow sheets; but that, although none of it appears to be in intrusive sheets, there are some dikes cutting across the sedimentary bedding. Surely that is not to be wondered at; and it is not surprising that such cases of dikes should occur more numerously among the older sedimentary beds. For those parts of the field are the ones where the upper beds have been wholly carried away by erosion, and with them whatever overflow sheets may have been supplied by the still remaining dikes.

The map shows that in New Jersey, the same as in Eastern Pennsylvania, the structure of the New Red is much less simple near its northwest border than towards its southeast; and that the old idea of nothing but northwesterly dips is far from correct.

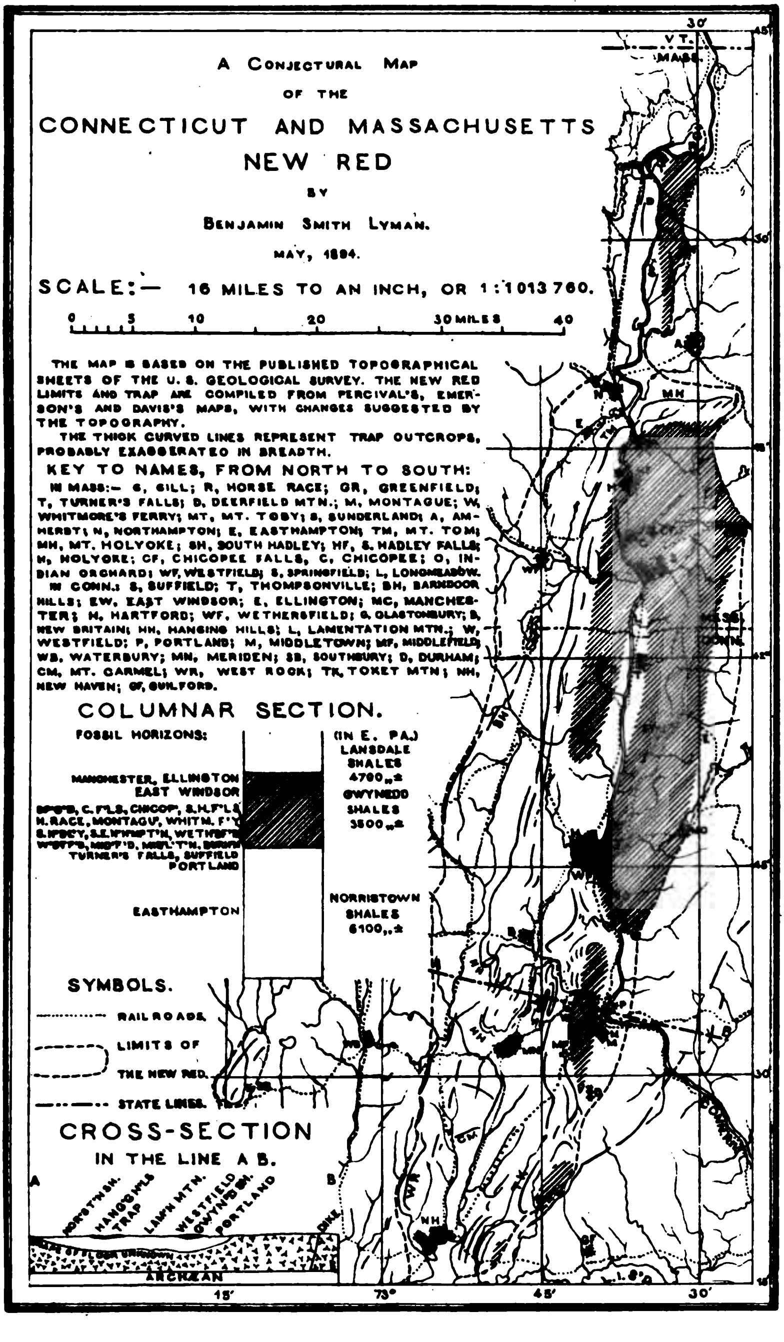
It is noticeable that the thickness of the New Red is much less towards the northeastern end of the field than it is near the Delaware and especially less than in Montgomery county, Pa.; and that the diminution is occasioned by the absence of the upper beds, while the lower ones do not seem to vary very greatly in amount.

The diminution extends into Connecticut in greater degree, and still more so in Massachusetts, as is to be seen in the accompanying map of the New Red there. It is possible that the idea of the very limited paleontological range and thickness of the whole American New Red may have largely originated in the small extent of the Massachusetts and Connecticut series, the earliest to be studied. Another error may perhaps be traced in great part to the same source. The New Red, namely, is persistently called New Red sandstone; though in Eastern Pennsylvania a very small part of the beds, perhaps hardly one-twentieth, are sandstone, and the rest are all shales, or at most sandy shales. In Massachusetts, however, a much larger share of the diminished series would appear to be sandstone; and that fact, together with the time-honored name of the English New Red sandstone was doubtless the cause of giving what is lithologically so inappropriate a name to our American rocks.

The accompanying little map of the Connecticut and Massachusetts

New Red is compiled from the United States Geological Survey topographical sheets so far as published (some parts of the Connecticut field being deficient), and from Percival's geological map of Connecticut, of 1842, and Prof. Emerson's map of the Massachusetts New Red, and Prof. Davis' partial mapping of the Connecticut New Red; but a number of changes have been made according to the indications of the topography. These geological maps gave, for our present purposes, chiefly the outside limits of the New Red and the occurrences of trap. The topography seemed to indicate clearly the necessity of reducing the extent of the trap, in some places very much; and, even as now drawn, the breadth of the trap may be, strictly speaking, somewhat exaggerated, though probably harmlessly so and not inconveniently for better conspicuousness. Notwithstanding the short-sighted niggardliness of the Connecticut government of the time, that did not enable Percival to give in his report more, he says, than "a hasty outline, written mainly from recollection," of his ample field observations, his map has been the great authority for the Connecticut New Red; but it is painful to find that the base itself of the map is extremely inaccurate, not unlike other maps of that date, and even later, in States further west and south. It is probable, also, that he considered every bowlder of trap to indicate that solid trap in place lay immediately below; and consequently many of his trap masses have no corresponding topographical indications. Prof. Davis has already made some just criticism of the map, and, for example, has said: "that the little ridges north of Toket mountain, marked with much detail of curvature on Percival's map, are disappointing when examined on the ground" (*U. S. Geol. Survey*, 7th Ann. Rept., p. 481). It seems highly improbable but that many of the numerous marks for trap on Percival's map cannot represent trap in place. In Eastern Pennsylvania, quite outside the region of glacial drift, exposures of trap in place are very rare, and it is not easy to suppose that they can be anything like so common as his map would seem to indicate in a region heavily covered with drift. It has consequently seemed proper enough to omit many of his smaller trap masses from the present map, wherever there was no topographical feature to corroborate their existence. The lack of the New Haven topographical sheet, not yet published, has perhaps led to the omission of some of the little trap masses that might have been inserted, but they would not be important for the present purpose.

As Prof. Davis has justly remarked, many of Percival's curves in the trap are simply the result of variations in the shape of the surface of the ground, where the outcrop of a bed or sheet, dipping gently, retreats as it sinks into a valley, or advances as it climbs a hill, and such curves may be properly retained. But some of Percival's curves do not seem to have any real support in the topography; and at other places, for example, north of Middletown, the topography gives quite a changed interpretation for the structure. In Massachusetts, too, near Mt. Toby and at the eastern end of Mt. Holyoke the topography seems to require the changes that have been made in the mapping of the trap.


A CONJECTURAL MAP
OF THE
CONNECTICUT AND MASSACHUSETTS
NEW RED
BY
BENJAMIN SMITH LYMAN.
MAY, 1894.
SCALE:— 16 MILES TO AN INCH, OR 1:1013760.
0 5 10 20 30 MILES 40
THE MAP IS BASED ON THE PUBLISHED TOPOGRAPHICAL SHEETS OF THE U. S. GEOLOGICAL SURVEY. THE NEW RED LIMITS AND TRAP ARE COMPILED FROM PERCIVAL'S, EMERSON'S AND DAVIS'S MAPS, WITH CHANGES SUGGESTED BY THE TOPOGRAPHY.
THE THICK CURVED LINES REPRESENT TRAP OUTCROPS, PROBABLY EXAGGERATED IN BREADTH.
KEY TO NAMES, FROM NORTH TO SOUTH:
IN MASS:— G, GILL; R, HORSE RACE; GR, GREENFIELD; T, TURNER'S FALLS; D, DEERFIELD MTN.; M, MONTAGUE; W, WHITMORE'S FERRY; MT, MT. TOBY; S, SUNDERLAND; A, AMHERST; N, NORTHAMPTON; E, EASTHAMPTON; TM, MT. TOM; MH, MT. HOLYOKE; SH, SOUTH HADLEY; HF, S. HADLEY FALLS; H, HOLYOKE; CF, CHICOPEE FALLS, C, CHICOPEE; O, INDIAN ORCHARD; WF, WESTFIELD; S, SPRINGFIELD; L, LONGMEADOW.
IN CONN.: S, SUFFIELD; T, THOMPSONVILLE; BH, BARNDOOR HILLS; EW, EAST WINDSOR; E, ELLINGTON; MC, MANCHESTER; H, HARTFORD; WF, WETHERSFIELD; G, GLASTONBURY; B, NEW BRITAIN; HH, HANGING HILLS; L, LAMENTATION MTN.; W, WESTFIELD; P, PORTLAND; M, MIDDLETOWN; MF, MIDDLEFIELD; WB, WATERBURY; MN, MERIDEN; SB, SOUTHBURY; D, DURHAM; CM, MT. CARMEL; WR, WEST ROCK; TK, TOKET MTN; NH, NEW HAVEN; GF, GUILFORD.
COLUMNAR SECTION.
FOSSIL HORIZONS:
MANCHESTER, ELLINGTON
EAST WINDSOR
PORTLAND
EASTHAMPTON
(IN E. PA.)
LANSDALE
SHALES
4700 „ ±
GWYNEDD
SHALES
3500 „ ±
NORRISTOWN
SHALES
6100 „ ±
SYMBOLS.
RAILROADS.
LIMITS OF
THE NEW RED.
STATE LINES.
CROSS-SECTION
IN THE LINE A B.
A
B
PORTLAND
ARCHÆAN
VT.
MASS.
CONN.
30'
45'
15'
73°
MH
DIKE

The map shows, in spite of some uncertainty about the true limits of the different subdivisions of the shales, that the quantity of the New Red that occurs in Connecticut and Massachusetts is probably decidedly less than in Central New Jersey, and that the diminution is still most likely due, not to a proportional thinning of the several subdivisions, but to the total absence of the upper beds, leaving the lower divisions apparently not very different in thickness from what they are in Eastern Pennsylvania. Their thickness, however, needs to be determined with more precision by a closer consideration of the hitherto only scantily published dips. Owing to this evident diminution of the total thickness, it is not necessary to retain, with reversed throws, the series of parallel longitudinal faults that has been proposed for Connecticut.

The geological structure indicated by the map seems very natural and quite in harmony with all the recorded facts and to make no serious fault necessary. The dips near Middletown and Portland and westward would seem to be very gentle, and "occasionally westerly" (J. D. Dana, *Am. Jour. Sci.*, 1891, Vol. xlii, p. 446), so as to justify the indication given of a very shallow basin there, bringing quite naturally the brownstone of the Norristown shales to the surface at Portland. There seems to be another narrower shallow basin or two just west of that one. A very low anticlinal (not a great fault) north of Meriden apparently enables the same brownstone to crop out so far north as Longmeadow, in the southern edge of Massachusetts. The geological structure towards the eastern edge of the New Red, to the dip, seems to be much more complicated than towards the western edge; just as in New Jersey and Pennsylvania it is so along the western edge, to the dip there.

The fossil horizons can be estimated roughly, but probably without very great error. The Easthampton (Mass.) fossil would seem to have come from somewhere near the middle of the Norristown shales; the Portland fossils from the same shales, somewhat nearer their top, and the fossils from the west bank of the Connecticut at the Enfield bridge in Suffield, and those of Turner's Falls again from the same shales, perhaps still closer to the top. The fossils of the small detached area at Southbury also belong probably to those shales, but possibly a little higher. The fossils of Durham, Middlefield, west of Middletown, Westfield (Conn.), Wethersfield, Mittineaque Falls in West Springfield, southeastern Northampton (close above Holyoke), northern South Hadley, Whitmore's Ferry (in Sunderland), Montague and the Horse Race (on Connecticut river in Gill), all seem to belong very closely to one horizon, and that just above the bottom of the Gwynedd shales. The fossils of Chicopee and those between Chicopee and Springfield (possibly those of Springfield, too, if not a little lower) and those of South Hadley Falls would seem to be from the same shales slightly higher up; and the fossils from Chicopee Falls again from the same shales, possibly still slightly higher up; and those from Amherst perhaps yet higher. The fossil bones from East Windsor would appear also to come from the Gwynedd shales, but near their top; and those

from Ellington and Manchester probably from just below their top. Almost all the New Red fossils in these two States, then, seem to have come from the Gwynedd shales, as we have seen is the case in the other States.

It may be worth while to give here lists of all the recorded New Red fossils, arranged according to the different horizons for the sake of easy comparison, beginning at the bottom and proceeding upwards.

### NORRISTOWN SHALES.

Very near the bottom, at Weehawken, N. J.:

Ischypterus Braunii, Newb. (Newb., U. S. Geol. Surv., Mon. xiv, p. 43).
Estheria ovata, Lea (N. J. Geol. Surv. Rep., 1888, pp. 26, 28, 29).
Plants (L. P. Gratacap, Am. Naturalist, xx, p. 245).
Footmarks (do., p. 246).

Likewise very near the bottom, at Shady Side, N. J.:

Estheria ovata, Lea (N. J. G. S. Rep., 1888, pp. 26, 29).
Imperfect remains of fishes (do., pp. 26, 29).

About 3500 feet below the top, below Norristown and at Ft. Washington, Pa.:

Undetermined plants, found a few days ago by Prof. Heilprin's geological class.

About 3000 feet below the top, at Greenville, four miles and a half easterly from Doylestown, Pa.:

Calamitoid plant (Schizoneura planicostata, Font.?), "near Doylestown" (N. Y. Ac. Sci. Trans., 1885, p. 17).
Calamites (?) undetermined (A. P. S. Proc., Vol. xxxiii, p. 7, Feb., 1894).

Towards the top, at the Rocky Hill quarries, a little west of Hartford, Conn.:

Footmarks (Hitchc., Mass. Geol. Rep., 1841, p. 466).

Towards the top, at Easthampton, Mass.:

Clathropteris platyphylla, Brong. (Newb., Mon. xiv, p. 94).
Brontozoum giganteum, E. H. (Suppl. to Ichn., p. 24).
Mollusk allied to Rudistæ Lamk. (?) (Hitchc., Ich., p. 6).

Towards the top, at Wilburtha, N. J.:

Estheria (N. J. G. S. Rep., 1888, p. 29).
Plant remains, imperfect (do., p. 29).

Towards the top, one mile above Prallsville, N. J.:

Estheria (N. J. Geol. Rep., 1888, p. 30).

Near the top, at Newark, N. J.:

Lepidodendron Weltheimianum, Presl. (N. J. G. S. Rep., 1879, p. 26).
Equisetum Meriani (?) (Newb., Mon. xiv, p. 86).
Dioönites longifolius, Emmons (do., p. 92).
Clathropteris platyphylla, Brong. (do., p. 94).
Palissya Braunii, Endl. (doubtful) (do., pp. 13, 94).

Near the top, at Belleville, N. J.:

Lepidodendron Weltheimianum, Presl. (N. J. G. S. Rep., 1879, p. 26).
Bone fragment, well preserved (Cook, N. J. Geol. Rep., 1885, p. 95).

Near the top, at Portland, Conn.:

Dendrophycus triassicus, Newb. (same as Desorii Lesqx., Newb., Mon. xiv, p. 82).
Cunichnoides marsupialoideus, E. H. (Ich., p. 55).
Brontozoum exsertum, E. H. (do., p. 67).
" validum, E. H. (do., p. 68).
" Sillimanium, E. H. (do., p. 69).
Grallator gracillimus, E. H. (?) (do., p. 74).
Isocampe Moodii, E. H. (do., p. 120).
Otozoum Moodii, E. H. (do., p. 125).
Hoplichnus equus, E. H. (do., p. 135).
Impressions of bones apparently ornithic (W. B. Rogers, Bost. Nat. Hist. Soc. Proc., Vol. vii, p. 396).

Near the top, between Wethersfield and Hartford, Conn.:

Plectropterna (Sauroidichnites) minitans, E. H. (1841, p. 482).

Near the top, at Suffield, Conn.:

Alga (Hitchcock, Mass. Geol. Rep., 1841, p. 453).
Plant, possibly a Voltzia (do., p. 451).
Brontozoum (Ornithoidichnites) giganteum, E. H. (do., pp. 466, 485).

Near the top, on Mt. Holyoke, Mass.:

Brontozoum validum, E. H. (Ich., p. 68).

Near the top, at Montague City, one mile south of Turner's Falls, Mass.:

Tridentipes ingens, E. H. (Ich., p. 89).

Near the top, at Turner's Falls, Mass.:

Pachyphyllum simile, Newb. (Newb., Mon. xiv, p. 88).
Pachyphyllum brevifolium (do., p. 89).
" peregrinum, Schimper (Font., U. S. G. Surv., Mon. vi, p. 108).
Actinopteris quadrifoliata, Font. (Font., Mon. vi, p. 121).
Ischypterus ovatus, W. C. R. (Newb., Mon. xiv, p. 27).
Ischypterus tenuiceps, Ag. (do., p. 33).
" parvus, W. C. R. (do., Pl. xiii).
Anomoepus intermedius, E. H. (Sup., p. 2).
" curvatus, E. H. (do., p. 5).
" minimus, E. H. (do., p. 5).
" gracillimus, E. H. (do., p. 6).
Anisopus gracilior, E. H. (do., p. 6).
Brontozoum divaricatum, E. H. (do., p. 7).
Grallator parallelus, E. H. (do., p. 7).
" gracilis, C. H. H. (do., p. 8).
Leptonyx lateralis, E. H. (do., p. 8).
Comptichnus obesus, E. H. (do., p. 9).
Trihamus elegans, E. H. (do., p. 9).
Anticheiropus hamatus, E. H. (do., p. 11).
Harpedactylus crassus, E. H. (do., p. 12).
" gracilior, E. H. (do., p. 12).
Lunula obscura, E. H. (do., p. 17).
Bisulcus undulatus, E. H. (do., pp. 66, 84).
Trisulcus laqueatus, E. H. (do., p. 19).
Grammichnus alpha, E. H. (do., p. 19).
Ampelichnus sulcatus, E. H. (do., p. 19) ("Possibly a plant").
Climacodichnus corrugatus, E. H. (do., p. 20).
Ænigmichnus multiformis, E. H. (do., p. 20).
Brontozoum giganteum, E. H. (Sup., p. 24).
" approximatum, E. H. (Sup., p. 24).
Brontozoum minusculum, E. H. (do., p. 24).
" exsertum, E. H. (do., p. 67).
" Sillimanium, E. H. (do., p. 69).
Brontozoum isodactylum, E. H. (do., p. 70).
Plesiornis mirabilis, E. H. (do., p. 83).
Anamœpus minor, E. H. (Ich., p. 58).
Anisopus Deweyanus, E. H. (Sup., p. 64).
Anisopus gracilis, E. H. (Ich., p. 62).
Amblonyx giganteus, E. H. (do., p. 71).
" Lyellianus, E. H. (do., p. 72).
Grallator cursorius, E. H. (do., p. 73).
" tenuis, E. H. (do., p. 73).
" gracillimus, E. H. (do., p. 74).
" cuneatus, E. H. (do., p. 75).
Platypterna recta, E. H. (do., p. 85).
" varica, E. H. (do., p. 86).
" gracillima, E. H. (do., p. 86).
Tridentipes elegantior, E. H. (do., p. 90).
Corvipes lacertoideus, E. H. (do., p. 98).
Plesiornis quadrupes, E. H. (do., p. 103).
Typopus abnormis, E. H. (do., p. 106).
Plectropterna minitans, E. H. (do., p. 109).
Plectropterna angusta, E. H. (Sup., p. 67).
" lineans, E. H. (do., p. 67).
Harpedactylus gracilis, E. H. (Ich., p. 113).
Xiphopeza triplex, E. H. (do., p. 113).

Antipus bifidus, E. H. (do., p. 116).
Chimæra Barratti, E. H. (do., p. 119).
Isocampe strata, E. H. (do., p. 120).
Otozoum Moodii, E. H. (do., p. 125).
Macropterna vulgaris, E. H. (do., p. 129).
" divaricans, E. H. (do., p. 129).
Shepardia palmipes, E. H. (do., p. 131).
Lagunculipes latus, E. H. (do , p. 132).
Selenichnus falcatus, E. H. (do., p. 133).
" breviusculus, E. H. (do., p. 134).
Hoplichnus poledrus, E. H. (do., p. 136).
Helcura caudata, E. H. (do., p. 141).
Helcura anguinea, E. H. (do., p. 141).
Exocampe arcta, E. H. (do., p. 142).
" ornata, E. H. (do., p. 143).
Harpagopus dubius, E. H. (do., p. 148).
Bifurculipes scolopendroideus, E. H. (do., p. 154).
Hexapodichnus horrens, E. H. (do., p. 158).
Copeza triremis, E. H. (do., p. 159).
Unisulcus Marshi, E. H. (do., p. 160).
" intermedius, E. H. (do., p. 161).
Unisulcus minutus, E. H. (do., p. 161).
Cunicularius retrahens, E. H. (do., p. 163).
" magnus, E. H. (do., p. 164).

Near the top, at the Lily Pond Quarry, on R. Field's farm, in Gill, near Turner's Falls, Mass.:

Acanthichnus alternans, E. H. (Sup., p. 14).
" anguineus, E. H. (do., p. 14).
" trilinearis, E. H. (do., p. 15).
Copeza propinquata, E. H. (do., p. 16).
" punctata, E. H. (do., p. 16).
Conopsoides curtus, E. H. (do., p. 16).
Harpepus capillaris, E H. (do., p. 16).
Sagittarius alternans, E. H. (do., p. 16).
Bisulcus undulatus, E. H. (do., pp. 55, 66, 76.
Brontozoum giganteum, E. H. (do., p. 24).
" approximatum, E. H. (do., p. 24).
Brontozoum minusculum, E. H. (Ich., p. 66).
Brontozoum tuberatum, E. H. (do., p. 66).
Plesiornis mirabilis, E. H.. (do., p. 83).
Anisopus Deweyanus, E. H. (Sup., p. 44).
" gracilis, E. H. (Ich., p. 62).
Grallator formosus, E. H. (do., p. 76).
Argozoum disparidigitatum, E. H. (do., p. 82).
Argozoum paridigitatum, E. H. (do., p. 82).
Tridentipes elegantior, E. H. (do., p. 90).
" uncus, E. H. (do., p. 92).
Gigantitherium caudatum, E. H. (do., p. 95).
Gigantitherium minus, E. H. (do., p. 95).
Hyphepus Fieldi, E. H. (do., p. 97).
Corvipes lacertoideus, E. H. (do., p. 98).
Tarsodactylus caudatus, E. H. (do., p. 99).
Apatichnus circumagens, E. H. (do., p. 100).
Plesiornis quadrupes, E. H. (do., p. 103).
Plesiornis pilulatus, E. H. (do., p. 104).
Orthodactylus floriferus, E. H. (do., p. 114).
" introvergens, E. H. (do., p. 114).
Orthodactylus flexiloquis, E. H. (do., p. 115).
Arachnichnus dehiscens, E. H. (do., p. 117).
Macropterna divaricans, E. H. (do., p. 129).
" gracilipes, E. H. (do., p. 130).
Cheirotheroides pilulatus, E. H. (do., p. 131).
Saltator caudatus, E. H. (do., p. 138).
Chelonoides incedens, E. H. (do., p. 140).
Helcura surgens, E. H. (do., p. 141).
" anguinea, E. H. (do., p. 141).
Exocampe arcta, E. H. (do., p. 142).
Ptilichnus anomalus, E. H. (do., p. 145).
" typographus, E. H. (do., p. 140).
" pectinatus, E. H. (Sup., p. 55).
" hydrodromus, E. H. (Ich., p. 146).
Acanthichnus cursorius, E. H. (do., p. 151).
" saltatorius, E. H. (do., p. 151).
Acanthichnus tardigradus, E. H. (do., p. 151).
Bifurculipes elachistotatus, E H. (do., p. 154).
Hexapodichnus magnus, E. H. (do., p. 158).
Cochlea archimedea, E. H. (do., p. 162).
Halysichnus laqueatus (do., p. 162).
" tardigradus (do., p. 163).

Near the top, on Field's farm, in Gill, near Turner's Falls, Mass.:

Plant, ten feet long (Hitchc., Ichn., p. 170).
Platypterna digitigrada, E. H. (Ich., p. 86).
Apatichnus bellus, E. H. (do., p. 101).
Plectropterna gracilis, E. H. (do., p. 109).
Orthodactylus linearis, E. H. (do., p. 115).
Stenodactylus curvatus, E. H. (do., p. 117).
Saltator bipedatus, E. H. (?) (do., p. 137).
Hamipes didactylus, E. H. (do., p. 150).
Conopsoides larvalis, E. H. (do., p. 152).
Bifurculipes laqueatus, E. H. (do., p. 153).
Bifurculipes tuberculatus, E. H. (do., p. 153).

Grammepus erismatus, E. H. (do., p. 156).
" unordinatus, E. H. (do., p. 156).
Lithographus hieroglyphicus, E H. (do., p. 156).
Lithographus cruscularis, E. H. (do., p. 157).
Cochlichnus anguineus, E. H. (do., p 161).
Sphaerapus larvalis, E. H. (do., p. 161).

### Near the top, in Field's orchard, in Gill, near Turner's Falls, Mass.:

Anisopus gracilis, E. H. (Ich., p. 62).
Stratipes latus, E. H. (do., p. 149).

### Near the top, at the quarry near Roswell Field's house, in Gill, Mass.:

Anamoepus major, E. H. (Ich., p. 57).

### Probably in the Norristown shales, at Southbury, Conn.:

Tree trunk (Hitchcock, Rep., 1841, p. 456).
Catopterus gracilis, J. H. R. (Newberry, Mon. xiv, p. 55).

## Gwynedd Shales.

### Towards the bottom at Egypt, N. C.:

Acrostichides Egyptiacus, Emmons (Font., Mon. vi, p. 99).

### Towards the bottom, in the Deep River coal field, N. C.:

Acrostichides princeps, Schenk (?) (Font., Mon. vi, p. 99).
Pariostegus myops, Cope (Cope, N. C. Geol. Rep., 1875, App., p. 32).
Dictyocephalus elegans, Leidy (do , p. 32).
Belodon caroliniensis, Emm. (do., p. 34).
" priscus, Leidy (do., p. 34).

### Towards the bottom, in the Dan River coal field, N. C.:

Cheirolepis Münsteri, Schimper (?) (Font., Mon. vi, p. 99).
Belodon Leaii, Emm., (Cope, N. C. Geol. Rep., 1875, App., p. 35).
Estheria ovata, Lea (T. R. Jones, Geol. Mag., vii, 1890, p 387).

### Towards the bottom, in North Carolina:

Equisetum Rogersi, Schimper (Font., Mon. vi, p. 98).
Sphenozamites Rogersianus, Font. (do., p. 98).

### Towards the bottom (?), in Moore county, N. C.:

Belodon Caroliniensis, Emm. (Cope, N. C. Rep., 1875, App., p. 34).
Belodon priscus, Leidy (do., p. 34).

### Towards the bottom (?), in Montgomery county, N. C.:

Belodon priscus, Leidy (Cope, N. C. Rep., 1875, App., p. 34).

### Towards the bottom (?), in Anson county, N. C.:

Belodon Caroliniensis, Emm. (Cope, N. C. Rep., 1875, App., p. 34).

### Towards the bottom, at Clover Hill, Va.:

Schizoneura planicostata, Rogers (Font., Mon. vi, p. 16).
Schizoneura (?), (1 specimen) (do., p. 16).
" Virginiensis, Font. (do., p. 18).
Macrotoeniopteris crassinervis, Feist (do., p. 23).
Acrostichides rhombifolius, Font. (do., p. 32).
Acrostichides rhombifolius, var. rarinervis, Font. (do., p. 33).
Acrostichides microphyllus, Font. (do., p. 34).
Acrostichides densifolius, Font. (do., p. 34).
Mertensides distomus, Font. (do., p. 40).
Asterocarpus Virginiensis, Font. (do., p. 45).
" " var. obtusiloba, Font. (do., p. 46).
Asterocarpus platyrachis, Font. (do., p. 47).
" penticarpa, Font. (do., p. 48).
Cladophlebis ovata, Font. (do., p. 51).

Cladophlebis microphylla, Font. (do., p. 52).
Cladophlebis pseudowhitbiensis, Font (do., p. 52).
Lonchopteris Virginiensis, Font. (do., p. 54).
Clathropteris platyphylla, var. expansa, Saporta, (do., p. 58).
Pseudodanæopsis reticulata, Font. (do., p. 60).
Pseudodanæopsis nervosa, Font. (do., p. 63).
Sagenopteris rhoifolia (?), (do., p. 63).
Dicranopteris, spec. (?), (do., p. 63).
Pterophyllum inæquale, Font. (do., p. 65).
Ctenophyllum truncatum, Font. (do., p. 69).
Ctenophyllum grandifolium, Font. (do, p. 76).
Ctenophyllum giganteum, Font. (do., p. 77).
Podozamites Emmonsi, Font. (do., p. 78).
" tenuistriatus, Rog. (do, p. 79).
Sphenozamites Rogersianus, Font. (do., p. 84).
Baiera multifida, Font. (do., p. 88).
Undetermined cones (do., p. 91).

Towards the bottom, at Midlothian, Va.:

Asterocarpus Virginiensis, Font. (Font., Mon. vi, p. 45).
Pseudodanæopsis reticulata, Font. (do., p. 60).
Pterophyllum affine, Nathorst (do., p. 66).
Ctenophyllum taxinum, L. and H. (do, p. 68).
Podozamites tenuistriatus, Rogers (do., p. 79).

Towards the bottom, at Gowry shaft, near Midlothian, Va.:

Acrostichides limnææfolius, Bunb. (Font., Mon. vi, p. 28).
Acrostichides rhombifolius, Font. (do., p. 32).
Mertensides bullatus, Bunb. (do., p. 39).
Zamiostrobus Virginiensis, Font (do., p. 85).

Towards the bottom, at Black Heath, Va.:

Acrostichides linnææfolius, Bunb. (Font., Mon. vi, p. 28).

Towards the bottom, at Aspinwall shaft, at Manakin, near Dover, Va.:

Equisetum Rogersi, Schimper (Font., Mon. vi, p. 11).
Asterocarpus Virginiensis, Font. (do., p. 45).
Pecopteris rarinervis, Font. (do., p. 49).
Cladophlebis subfalcata, Font. (do., p. 49).
Lonchopteris Virginiensis, Font. (do., p. 54).

Towards the bottom, at Carbon Hill, Va.:

Schizoneura planicostata, Rog. (Font., Mon. vi, p. 16).
Acrostichides rhombifolius, Font. (do., p. 32).
Mertensides bullatus, Bunb. (do., p. 39).
Asterocarpus Virginiensis, Font. (do., p. 45).
Pecopteris rarinervis, Font. (do., p. 49).
Cladophlebis auriculata, Font. (do., p. 50).
Pseudodanæopsis reticulata, Font. (do., p. 60).
Ctenophyllum Braunianum, var. *a*, Goepp. (do., p. 73).
Podozamites tenuistriatus, Rog. (do., p. 79).
Baiera multifida, Font. (do., p. 88).

Towards the bottom, at Deep Run, Va.:

Podozamites tenuistriatus, Rog. (Font., Mon. vi, p. 79).

Towards the bottom, in the Richmond basin, Va.;

Catopterus gracilis, J. H. R. (Newb., Mon. xiv, p. 11).
Dictyopyge macrura, Egt. (do., p. 11).
Ischypterus ovatus W. C. R. (do., p. 11).

Towards the bottom, in the Farmville, Cumberland county, Va., area:

Equisetum Rogersi, Schimper (Font., Mon. vi, p. 12).
Pterophyllum decussatum, Emmons (do., p. 67).
Podozamites tenuistriatus, Rog. (do., p. 79).
Cheirolepis Münsteri, Schimper (do.. p. 89).
Bambusium (?) (do., p. 90).

Towards the bottom, in the Hanover county, Va., area :

Equisetum Rogersi, Schimper (Font., Mon. vi, p. 12)

Cladophlebis rotundiloba, Font. (do., p. 53).

# ERRATA.

Please insert the two following lists of fossils at the first break on page 209:

Towards the bottom, about two miles north of west of Emigsville, York County, Pa.:

Belodon Priscus, Leidy (Cope, A. P. S. Proc., 1886, Vol. xxiii, p. 403).
Belodon Carolinensis, Emmons (do., p. 403).
Palæosaurus Fraserianus, Cope (do., p. 404).
Suchoprion cyphodon, Cope (do., p. 404).
" aulacodus, Cope (do., p. 404).
Clepsysaurus Veatleianus, Cope (do., p. 404.)
Palæoctonus appalachianus, Cope (do., p. 404).
Thecodontosaurus gibbidens, Cope (do., p. 404).

Towards the bottom, four miles "eastward" from the Goldsboro fossil footprints, York Co., Pa. :

Ramulus rugosus, Wanner (Pa. Geol. Rep., 1887, p. 27).

On page 212, eight lines from the top, instead of "Reading" read *Pennsylvania*.

On page 214, seven lines from the top, instead of "bottom" read *top*.

[illegible] 121).
Argozoum disparidigitatum, E. H. (Ich., p. 82).
Argozoum paridigitatum, E. H. (do., p. 82).
Grallator cuneatus (C. H. H., Bost. N. H. S., xxiv, p. 121).
Grallator tenuis (do., p. 121).
[illegible] N. H. S., xxiv, p. 122).
Plectropterna gracilis, E. H. (do., p. 122).
Pletropterua lineans, E. H. (Suppl., p. 71).
Plesiornis giganteus, C. H. H. (B. N. H. S., xxiv, p. 122).
Plesiornis æqualipes, E. H. (do., p. 122).
" n. sp. (do , p. 122).
Trihamus elegans, E. H. (do., p. 122).

Cladophlebis microphylla, Font. (do., p. 52).
Cladophlebis pseudowhitbiensis, Font (do.,

Pterophyllum inæquale, Font. (do., p. 65).
Ctenophyllum truncatum, Font. (do., p. 69).

Catopterus gracilis, J. H. R. (Newb., Mon. xiv, p. 11).
Dictyopyge macrura, Egt. (do., p. 11).
Ischypterus ovatus W. C. R. (do., p. 11).

Towards the bottom, in the Farmville, Cumberland county, Va., area :

Equisetum Rogersi, Schimper (Font., Mon. vi, p. 12).
Pterophyllum decussatum, Emmons (do., p. 67).
Podozamites tenuistriatus, Rog. (do., p. 79).
Cheirolepis Münsteri, Schimper (do., p. 89).
Bambusium (?) (do., p. 90).

Towards the bottom, in the Hanover county, Va., area :

Equisetum Rogersi, Schimper (Font., Mon. vi, p. 12)

Macrotaeniopteris magnifolia, Schimper (do., p. 20).

Cladophlebis rotundiloba, Font. (do., p. 53).

Cycadites tenuinervis, Font. (do., p. 84).

Near the bottom, near Durham, Conn.:

Baiera Münsteriana, Ung. (Newb., Mon. xiv, p. 84).

Schizoneura planicostata, Rogers (do., p. 87).

Pachyphyllum brevifolium, Newb. (Newb., Mon xiv, p. 89).

Otozamites latior, Saporta (do., p. 90).

" brevifolius, T. Br. (do., p. 91).

Cycadiocarpus Chapini, Newb. (do., p. 92).

Loperia simplex, Newb. (do., p. 93).

Clathropteris platyphylla, Brong. (do., p. 94).

Ischypterus micropterus, Newb. (do., p. 32).

Ischypterus tenuiceps, Ag. (do., p. 34).

" minutus, Newb. (do., p. 48).

Catopterus Redfieldi, Egerton (do., p. 53).

" gracilis, J. H. R. (do., p. 55).

" minor, Newb. (do., p. 57).

" ornatus, Newb. (do., Pl. xviii).

" anguilliformis, W. C. R. (do., p. 60).

Ptycholepis Marshii, Newb. (do., p. 67).

Diplurus longicaudatus, Newb. (do., p. 74).

Near the bottom, at Middlefield, Conn.:

Ischypterus ovatus, W. C. R. (Newb., Mon. xiv, p. 27).

Ischypterus fultus, Ag. (do., p. 34).

Brontozoum giganteum, E. H. (Suppl. Ichn., p. 24).

Plesiornis æqualipes, E. H. (Ichn., p. 105).

Typopus gracilis, E. H. (do., p. 106).

Near the bottom, at Middletown (west of the village), Conn.:

Fucoid, undetermined (Hitchc., 1841, p. 453).

Catopterus gracilis, J. H. R. (Newb., Mon. xiv, p. 35).

Catopterus anguilliformis, W. C. R. (?) (do., p. 59).

Anisopus Deweyanus, E. H. (Ich., p. 61).

" gracilis, E. H. (do., p. 62).

Chimaera Barratti, E. H. (?) (do , p. 119).

Cunicularius retrahens, E. H. (do., p. 163).

Near the bottom, at Westfield, Conn.:

Ischypterus ovatus, W. C. R. (Newb., Mon. xiv, p. 27).

Ischypterus fultus, Ag. (do., p. 34).

Ischypterus parvus, W. C. R. (?) (do., p. 45).

Catopterus anguilliformis, W. C. R. (?) (do., p. 59).

Near the bottom, at the Cove, in Wethersfield, Conn.:

Fucoid, undetermined (see Hitchcock, Mass. Geol. Rep., 1841, p. 450).

Plants, undetermined (do., p. 451).

Coprolites (?) (do., p. 461).

Brontozoum giganteum, E. H. (Suppl., p. 24).

Brontozoum minusculum, E. H. (do., p. 24).

Brontozoum divaricatum, E. H. (C. H. H., Bost. Nat. Hist. Soc., xxiv, p. 121).

Brontozoum Sillimanium, E. H. (do., p. 121).

Argozoum disparidigitatum, E. H. (Ich., p. 82).

Argozoum paridigitatum, E. H. (do., p. 82).

Grallator cuneatus (C. H. H., Bost. N. H. S., xxiv, p. 121).

Grallator tenuis (do., p. 121).

Corvipes lacertoideus, E. H. (do., p. 122).

Anomoepus curvatus (do., p. 121).

Platypterna Deaniana, E. H. (Ich., p. 83).

" tenuis, E H. (do., p. 84).

" delicatula, E. H. (do., p. 84).

Ornithopus gallinaceus, E. H. (do., p. 87).

" gracilior, E. H. (do., p. 88).

Tridentipes insignis, E. H. (do., p 91).

Plectropterna minitans (do., p. 109).

" elegans, E. H. (C. H. H., B. N. H. S., xxiv, p. 122).

Plectropterna gracilis, E. H. (do., p. 122).

Pletropterua lineans, E. H. (Suppl., p. 71).

Plesiornis giganteus, C. H. H. (B. N. H. S., xxiv, p. 122).

Plesiornis æqualipes, E. H. (do., p. 122).

" n. sp. (do , p. 122).

Trihamus elegans, E. H. (do., p. 122).

Trihamus magnus, C. H. H. (do., p. 122).
Triænopus leptodactylus, E. H. (Ichn., p. 111).
Harpedactylus, n. sp. (C. H. H., B. N. H. S., xxiv, p. 122).
Typopus abnormis, E. H. (do., p. 122).
Comptichnus, n. sp. (do., p. 122).
Ancyropus heteroclitus, E. H. (Ich., p. 139).
Acanthichnus cursorius, E. H. (do., p. 139).
Acanthichnus cursorius var. trilinearis, E. H. (do., p. 139).
Acanthichnus cursorius var. alatus, E. H. (do., p. 139).
Conopsoides larvalis, E. H. (Ich., p. 152).
Unisulcus minutus (C. H. H., B. N. H. S., xxiv, p. 122).
Bisulcus (do., p. 122).
Trisulcus (do., p. 122).
Cochlichnus, 2 sp. (do., p. 122).
Sagittarius and other footmarks (do., p. 122).

Near the bottom, at Mittineaque Falls, in West Springfield, Mass.:

Footmarks (Hitchcock, Mass. Geol. Rep., 1841, p. 466).

Near the bottom, at West Springfield, Mass.:

Coprolite (?) (Hitchcock, Mass. Geol. Rep., 1841, p. 461).

Near the bottom, in southeastern Northampton, Mass.:

Anisopus gracilis, E. H. (Ich., p. 62).
Brontozoum minusculum, E. H. (do, p. 66).
Brontozoum exsertum, E. H. (do, p. 67).
" validum, E. H. (do., p. 68).
" Sillimanium, E. H. (do., p. 69).
Brontozoum isodactylum, E. H (do., p. 70).
Brontozoum giganteum, E. H. (Sup., p. 24).
" approximatum, E. H. (do., p. 24).
Tridentipes ingens, E. H. (Ich, p. 89).
" insignis, E. H. (do., p. 91).
Palamopus Clarki, E. H. (do., p. 127).

Near the bottom, in South Hadley, Mass.:

Anisopus gracilis, E. H. (Ich., p. 62).
Brontozoum Sillimanium, E. H. (do., p. 69).
" isodactylum, E. H. (do., p. 70).
Grallator cursorius, E. H. (do., p. 73).
Grallator tenuis, E. H. (do., p. 73).
" gracillimus, E. H. (do, p. 74).
Batrachoides nidificans, E. H. (do., p. 123).

Near the bottom, in the north part of South Hadley, Mass.:

Anisopus Deweyanus, E. H. (Sup., p. 45).
Brontozoum giganteum, E. H. (Sup., p. 24).
Grallator cuneatus, E. H. (Ich., p. 75).
Batrachoides nidificans (do, p. 123).
Otozoum Moodii, E. H. (do., p. 125).

Near the bottom, at Whitmore's Ferry, in Sunderland, Mass.:

Plants (Hitchc., Mass. Geol. Rep, 1841, p. 450).
Fishes (do., p. 458).
Schizoneura planicostata, Rog. (Newb., Mon. xiv, p. 12).
Clathropteris platyphylla, Brong. (do., p. 94).
Pachyphyllum simile, Newb. (do., p. xxii).
Ischypterus ovatus, W. C. R. (do., p. 27).
" Marshii, W. C. R. (do., p. 29).
" Agassizii, W. C. R. (do., p. 30).
" parvus, W. C. R. (do, p. 45).
" latus, J. H. R. (do, p. 46).
" tenuiceps, Ag. (do., Pl. v, vii).

Near the bottom, at Marsh's quarry, in the southwest part of Montague, Mass.:

Anticheiropus pilulatus, E. H. (Sup., p. 10).
Tridentipes elegans, E. H. (do., p. 90).
Tridentipes insignis, E. H. (do., p. 91).
Chimæra Baratti, E. H. (?) (do., p. 119).

Near the bottom, at two miles south of Turner's Falls, in Montague, Mass.:

Tridentipes elegans, E. H. (Ich., p. 90).

Near the bottom, in Montague, Mass:

Clathropteris, obscure (Font., Mon. vi, p. 58).

Near the bottom, in the north part of Montague, Mass.:

Tridentipes elegans, E. H. (Ich., p. 90).

Near the bottom, at the Horse Race, in Gill, Mass.:

Brontozoum giganteum, E. H. (Sup., p. 24).
" approximatum, E. H. (do., p. 24).
Argozoum paridigitatum, E. H. (Ich., p. 82).
Ornithopus gallinaceus, E. H. (do., p. 87).
Tridentipes ingens, E. H. (do., p. 89).
" elegans, E. H. (do., p. 90).
" insignis, E. H. (do., p. 91).
Hoplichnus equus (do., p. 35).

Near the bottom, in Gill, Mass.:

Dictyophyllum, or Camptop'eris (Font., Mon. vi, p. 58).

Somewhere near the bottom, at Springfield, Mass.:

Anchisaurus polyzelus (Hitchcock, Supp. Ichn., 1865, p. 39; and Marsh, Am. Jour. Sci, xxxvii, p. 332, 1889).
Coprolite (?) (Hitchc., Mass. Geol. Rep., 1841, p. 461).

Somewhere near the bottom, one mile south of Chicopee, on the road to Springfield, Mass.:

Ancyropus (Sauroidichnites) heteroclitus, E. H. (1841, p. 479).
Plectropterna (Sauroidichnites) minitans, E. H. (1841, p. 482).
Polemarchus gigas, E. H. (Ich., p. 108).

Somewhere near the bottom, at Chicopee, Mass.:

Plant resembling Lemania (Hitchc., Rep., 1841, p. 450).

Somewhere near the bottom, at South Hadley Falls, Mass.:

Plant, undetermined (Hitchc., Mass. Rep., 1841, p. 452).
Harpagopus dubius, E. H. (?) (Ich., p. 148).
Fishes (Newb., Mon. xiv, p. 21).

Towards the bottom, at Chicopee Falls, Mass.:

Plant, perhaps a Fucoid (Hitchc., Mass. Rep., 1841, p. 453).
Footmarks (do., p. 466).
Pycnodont fish tooth (do., p. 460).
Acentrophorus Chicopensis, Newb. (Newb., Mon. xiv, p. 70).
Argozoum Redfieldianum, E. H. (Ich., p. 82).
Argozoum disparidigitatum, E. H. (Ich., p. 82).
Ornithopus gallinaceus, E. H. (do., p. 87).
Polemarchus gigas, E. H. (do , p. 108).

Towards the bottom, at Ellingtons, N. C.:

Laccopteris Münsteri, Schenk (Font., Mon. vi, p. 102).
Laccopteris elegans, Presl. (do., p. 102).
Lonchopteris oblongus, Emmons (do., p. 103).
Sagenopteris rhoifolia (do., p, 104).
Acrostichides rhombifolius, Font. (do., p. 105).
Palissya diffusa, Emmons (do., p. 107).
Cheirolepis Münsteri, Schimper (do., p. 108).
Equisetum Rogersi, Schimper (do., p. 109).
Podozamites Emmonsi, Font. (do., p. 111).
Pterophyllum decussatum, Emmons (do., p 111).
Pseudodanæopsis reticulata, Font. (do., p. 116).
Ctenophyllum, type of imbricatum (do., p. 116).

Below the middle, at Klinesville, N. J.:

Lamellibranch, undetermined (N. J. Geol. Rep., 1888, p. 29).
Cypris (do., p. 30).
Estheria (do., p. 30).

Near the middle, at Manchester, Conn.:

Anchisaurus major, Marsh (Am. Jour. Sci., 1889, xxxvii, p. 331).

About the middle, at Haywood, N. C.:

Cladophlebis obtusiloba, Andrae (?) (Font., Mon. vi, p. 105).
Ctenophyllum Braunianum, var. β, Goepp. (do., p. 112).

Perhaps about the middle, at five miles north of Haywood, N. C.:

Baiera multifida, Font. (Font., Mon. vi, p. 118).

Perhaps about the middle, at House's quarry, on the Haw river, N. C.:

Ctenophyllum Emmonsi, Font. (Font., Mon. vi, p. 113).
Ctenophyllum lineare, Font. (do., p. 114).
Pterophyllum spatulatum, Font. (do., p. 114).
Zamiostrobus Emmonsi, Font. (?) (do., p. 117).

At about 1500 feet below the top, at the south entrance of the Reading railroad tunnel, near Phœnixville, Pa.:

Plants (H. C. Lewis, Science, 1884, Vol. iii, p. 295).
Unio, 2 species (do., p. 295).
Marine lamellibranchs, 3 species (do., p. 295).
Ganoid fish (do., p. 295).
Saurian (?) (do., p. 295).

At about 1000 feet below the top, in the Reading railroad tunnel, near Phœnixville, Pa.:

Estheria Hindei, T. Rup. Jones (Geol. Mag., 1891, viii, p. 51).
Estheria Lewisii, T. Rup. Jones, "Red S. S. of Bucks county, Pa." (do., 1890, vii, p. 385).
Ganoid fishes (Leidy, A. N. S. Proc., 1859, Apr. 5).
Clepsysaurus (?) teeth (do., do.). (These are Belodon teeth, according to Cope.)
Eurydorus serridens (do., do.).
Compsosaurus (?) (do., do.).
Eupelor durus (Cope, do, 1866, p. 249, and A. P. S. Trans., 1868, xiv, p. 25).
Belodon Caroliniensis, Emm. (Cope, A. P. S. Proc., 1886, xxiii, p. 403).
Belodon lepturus, Cope (A. P. S. Trans., 1868, xiv, p. 59).
Rhabdopelix longispinis, Cope (?) (do., p. 174).
Dicynodon rosmarinus (do., 232).
Batrachian tracks (Cope, do., p. 242).
Coprolites (Wheatley, A. N. S. Proc, 1859, p. 110).
Limulus (?) (do., p. 110).
Equisetum columnare, Brg. (do., p. 110).
Pterozamites longifolius, Emm. (do., p. 110).
Gymnocaulus alternatus, Emm. (do., p. 110).
Fir Cones (Lea, A. J. S., 1856, xxii, p. 123).
Calamites punctata (do., p. 123).
Dictyocaulus striatus (do., p. 123).
Estheria ovata, Lea (Wheatley, A. N. S. Proc., 1861, Vol xxxii, p. 43).
Estheria parva, Lea (do., p. 43).
Cypris, 2 species (do, p. 43).
Myacites Pennsylvanicus, Conrad (A. N. S. Proc., 1857, p. 86).
Radiolepis speciosus, Emm. (Lea, do., 1857, July 7).
Centemodon sulcatus, Lea (do., 1856, Mar., p. 77).
Chelichnus Wymanianus, Lea (do., p. 77).
Catopterus gracilis, Redf. (Wheatley, A. J. S., 1861, p. 41).

At about 1000 feet below the top, near Yerkes Station, Montgomery county, Pa.:

Radiolepis elegans Emm. (Leidy, A. N. S. Proc., 1876, May 9, p. 81).

At about 1000 feet below the top, at the Gwynedd tunnel, Montgomery county, Pa.:

Cypris (Leidy, Ac. Nat. Sci. Proc., 1857, June 16).
Batrachian (?) bones and teeth (do., do.).
Radiolepis speciosus, Emm. (Lea, do., 1857, July 7).
Eurydorus serridens (?) (Leidy, do., 1859, Apr. 5).
Rhabdopelix longispinis, Cope (A. P. S. Trans., 1868, xiv, p. 174).
Turseodus acutus, Leidy (A. N. S. Proc., 1857, June, p. 167).

Towards the top, "2000 feet or more above the coal measures," at Lockville, Chatham county, N. C.:

Sagenopteris rhoifolia (Font., Mon. xiv, p. 104).
Palissya Braunii, Endl. (do., p. 107).
Cheirolepis Münsteri, Schimper (do., p. 108).
Cycadites Roemeri, Schenk (?) (do., p. 109).
Cycadites longifolius, Emm. (?) (do., p. 110).
Pterophyllum pectinatum, Emm. (do., p. 112).
Zamiostrobus Emmonsi, Font. (?) (do., p. 117).
Otozamites Carolinensis, Font. (do., p. 117).
Araucaria (?) (do., p. 118).
Araucarites Carolinensis, Font. (do., p. 119).

Towards the top, at Ketch's mills, in the east part of East Windsor, Conn.:

Bones, undetermined (Hitchc., Mass. Geol. Rep., 1841, p. 503).

Towards the top, at Ellington (Ct.):

Bones, undetermined (Hitchc., Mass. Geol. Rep., 1841, p. 504).

Perhaps towards the top, at Amherst, Mass.:

Fishes (Newb., Mon. xiv, p. 21).

Towards the top, at Washington's Crossing, N. J.:

Estheria (N. J. Geol. Rep., 1888, p. 30).
Fishes (do., p. 30).

Very near the top, at Tumble Station, N. J.:

Footmarks (Nason, N. J. Geol. Rep., 1888, p. 29).

## Lansdale Shales.

Towards the bottom, at Little Falls and Pleasantdale, N. J.:

Plants, abundant (Nason, N. J. Geol. Rep., 1888, p. 23).

Towards the bottom, near Feltville, N. J.:

Cypris (?) (Nason, N. J. Geol. Rep., 1888, p. 22).

Towards the bottom, at Fields' copper mine, near Warrenville, and near Plainfield, N. J.:

Estheria (Nason, N. J. Geol. Rep., 1888, p. 30).
Fishes (do., pp. 29, 30).

Towards the bottom, near Washingtonville, N. J.:

Plants (Nason, N. J. Geol. Rep., 1888, p. 27).

Towards the bottom, near Martinsville, N. J.:

Tree trunks and ferns (Nason, N. J. Geol. Rep., 1888, p. 27).

Towards the bottom, near Pluckamin, N. J.:

Plants (Nason, N. J. Geol. Rep., 1888, p. 23).

About the middle, near New Providence, N. J.:

Plants (Nason, N. J. Geol. Rep., 1888, p. 28).

About the middle, near Whitehall, N. J.:

Tridentipes ingens, E. H. (C. H. H., Bost. Soc. N. Hist., xxiv, p. 122).
Brontozoum giganteum, C. H. H. (do., p. 122).
Brontozoum minusculum, E. H. (do., p. 122).
Brontozoum Sillimanium, E. H. (do., p. 122).
Grallator formosus, E. H. (do., p. 122).
Grallator parallelus, E. H. (do., p. 122).
" cursorius, E. H. (do., p. 122).
Anomœpus intermedius, E. H. (do., p. 122).

Apatichnus crassus, C. H. H. (do., p. 122).
Anisichnus gracilis, E. H. (do., p. 122).
Brontozoum isodactylum (Cook, N. J. Geol. Rep., 1885, p. 96).
Brontozoum divaricatum, E. H. (do., p. 96).

Towards the top, at Pompton furnace, N. J.:

Ischypterus Agassizii, W. C. R. (Newb., Mon. xiv, p. 30).

Perhaps towards the bottom, one mile south of Goldsboro, York county, Pa.:

Ramulus rugosus, Wanner (A. Wanner, Pa. Geol. Rep., 1887, p. 27).
Algæ (do., p. 21.)
Anomœpus gracillimus, C. H. H. (Bost. Nat Hist. Proc., xxiv, p. 123).
Brontozoum Sillimanium, E. H. (do., p. 123).
Anisichnus gracilis, E. H. (do., p. 123).

## Perkasie Shales.

Near the bottom, at Smith Clark's quarry, near Milford, N. J.:

Palæophycus limaciformis, H. C. Lewis (A. N. S. Proc., Nov., 1880, p. 93).
Schizoneura planicostata, Rog. (Newb., Mon. xiv, p. 11).
Equisetum Rogersi, Schimper (do., p. 85).
Cheirolepis Münsteri, Schimper (do., p. 89).
Clathropteris platyphylla, Brg. (do., p. 94).
Grallator parallelus, E. H. (C. H. H., Bost. Nat. Hist. Soc., xxiv, p. 122).
Grallator cuneatus, Barratt (do., p. 122).
" gracilis, C. H. H. (do., 122).
Chimærichnus ingens, C. H. H. (do., p. 122).
Polemarchus gigas, E. H. (do., p. 122).
Argozoum disparidigitatum, E. H. (do., p. 122).
Otozoum parvum, C. H. H. (do., p. 122).
Unisulcus magnus, C. H. H. (do., p. 122).
Sagittarius (do., p. 122).
Brontozoum isodactylum, E. H. (Eyerman, Ac. Nat. Sci. Proc., 1889, p. 32).
Grallator tenuis, E. H. (do., p. 32).
Anomœpus minor, E. H. (do., p. 32).
Harpagopus dubius, E. H. (do., p. 32).
Unisulcus marshi, E. H. (do., p. 32).
" minutus, E. H. (do., p. 32).

Near the bottom, at Boonton, N. J.:

Ischypterus ovatus, W. C. R. (Newb., Mon. xiv, p. 27).
Ischypterus Agassizii, W. C. R. (do., p. 30).
" tenuiceps, Ag. (do., p. 34).
" fultus, Ag. (do., p. 34).
" robustus, Newb. (do., p. 37).
" elegans, Newb. (do., p. 37).
" alatus, Newb (do., p. 38).
" modestus, Newb. (do., p. 39).
" lenticularis, Newb. (do., p. 39).
" lineatus, Newb. (do., p. 41).
Ischypterus macropterus, W. C. R. (do., Pl. xii).
Ischypterus parvus, W. C. R. (?) (do., p. 45).
Ischypterus gigas, Newb. (do., Pl. xiv).
Catopterus parvulus, W. C. R. (do., p 61).
" gracilis, J. H. R. (do., p. 55).
Diplurus longicaudatus, Newb. (do., p. 74).
Brontozoum approximatum, C. H. H. (Bost. Nat. Hist. Soc., xxiv, p. 123).
Grallator formosus, E. H. (do., p. 123).

Towards the bottom, at New Vernon, N. J.:

Footmarks, imperfect (Cook, N. J. Geol. Rep., 1885, p. 95).

## Norristown Shales.

About 5000 feet above the bottom, in Upper Milford township, Lehigh county, Pa.:

Clepsysaurus Pennsylvanicus, Lea (Lea, A. N. S. Jour., 1883, p. 185).

These lists probably show satisfactorily that there is no serious paleontological obstacle to accepting the views here set forth in regard to the New Red; certainly none to compare in seriousness with the obstacles that were boldly overridden repeatedly in making the Portland and Newark fossils Triassic.

Although the account just given puts quite another face upon the New Red with the unquestionably great thickness in Pennsylvania, and the partly conjectural, but quite harmoniously corresponding, condition of the beds in other States, yet it is clear that what is most extraordinary about the present views, so far as they are speculative, is that, for New Red speculations, they are so little extraordinary, so free from extravagance, so natural, probable and simple, yet so fully capable of explaining all the observed facts. It is seen that, although the New Red beds do not everywhere exist in the same completeness as in Montgomery county, yet that certain portions are pretty fully represented in distant States, the lower third in Connecticut, the lower half in Northeastern New Jersey, and the lower portions and upper portions in separate basins in Virginia. It is further plain that almost all, if not quite all, the fossils from which the Rhaetic, or Triassic, or Jurassic age of our New Red has been inferred, come from the Gwynedd shales alone; and that the few fossils from other parts of the whole New Red series have either been useless as indications of age or have been flatly disregarded. Hence it is not improbable that the Norristown shales, with the great calamite near Doylestown, the apparent Lepidodendron at Newark and Belleville, and the Palæophycus at Portland, may after all prove to be at least as old as the Permian. It seems, indeed, highly probable that the well-ascertained great thickness of 27,000 feet in Montgomery county should represent more than one limited paleontological period, and not only that it should include the Permian, but that the very extensive upper third of that space, hitherto almost devoid of reported fossils, should turn out to be much newer than the Triassic. Those upper beds have also shown here and there imperfect fossil traces, and as there are occasional beds of green shales among the predominant red ones, there is reason to hope that more abundant and perfect fossils may some day be found.

As for the trap, it seems impossible to doubt any longer that all the conformable trap sheets are overflows contemporaneous with the sedimentary beds, and not subsequent intrusions.

It is furthermore at any rate evident that thoroughly geological methods, as distinguished from purely paleontological ones, are of great importance in working out the geology, that is, the structure, the cross-sections, the columnar section and the outcrops of any region, but especially of one where fossils are scarce; and that the topography is extremely useful as an aid to understanding the geology.

## *Remarks on Mr. Lyman's Paper.*

*By Dr. Persifor Frazer.*

The paper of Mr. Lyman is astonishing in the fact that it does not mention the seven years' work by the Second Geological Survey of Pennsylvania on the New Red in York, Adams, Cumberland and Lancaster counties; although the method he advocates was the very method there adopted, viz., the careful topographical and geographical plotting of the region and the accurate location of every dip. There is neither justice nor expediency in ignoring years of work by a colleague, especially when one occupies a quasi directorship of the Survey under whose auspices the work was done.

From the section across the counties of York and Adams, from the town of York to Dillsburg, made in 1875, careful descriptions of the successive beds were made, as well as notes of their dip, and from these data a column was constructed for correlation with the columns of the Permian, Triassic and Jurassic in England and in Germany. In a paper contributed to Vol. v, *Trans. American Institute of Mining Engineers*, founded on the work done in 1874 in Southeast Pennsylvania, it was suggested that the basal conglomerate of the New Red might find its analogue in the magnesian limestone of England and the Zechstein of Germany, both of which represent the top of the Permian in the respective countries.

The thickness of the strata calculated by H. D. Rogers from the Yardleyville-New Hope-Attleboro' section, and confirmed by the writer, was 51,500 feet, or 15.75 kilometers, but neither Prof. Rogers nor the speaker believed that this represented the actual state of the case. It was stated that the New Red seemed to extend from some point in the Permian, at least, to the base of the Lias, including all the rocks attributed to the Trias and the beds below it, except the lower Rothliegendes of the German scale.

It is added, in the same paper, as a matter of frequent remark that all the beds of the "New Red" are not red. On the contrary, perhaps one-half of the whole series presents to the eye a lead-gray and drab color. It was suggested as possible that the black calcareous slates of Phœnixville might represent a lower horizon than the coal-bearing belt (near Ewingsville?) referred to in the catalogue of specimens of Report C, of York county, for 1874.

With reference to the subordinate position which paleontological should bear to stratigraphical evidence, the case would seem to be not quite fairly stated. If there were everywhere a complete column of strata of which the mutual relations were unmistakable, then paleontological evidence would be forced to conform itself to the column as best it might. But the case is like that of the relation between the astronomical transit and the compass, or the level and the barometer—the latter is invaluable

where the former cannot be employed. For coördination of series in two distant places between which there is no stratigraphical connection, paleontological evidence is the only evidence available.

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## *On the Lungs of the Ophidia.*

*By Prof. E. D. Cope.*

*(Read before the American Philosophical Society, May 18, 1894.)*

The condition of knowledge as to the characters of the lungs of snakes was stated by Stannius, in 1856,* as follows: "The detailed accounts as to the single or double character of the lungs leave much to be desired. Among Ophidia Angiostomata there possess a single sack, Rhinophis and all Typhlopidæ which have been examined; as to the Tortricidæ [Ilysiidæ], there are apparently species with two lungs (*T. xenopeltis*) [= *Xenopeltis unicolor*], and others with a single lung (*T. scytale*) [= *Ilysia scytale*]. Among Eurystomata, all the Peropoda (Boa, Python, Eryx) possess apparently two lungs. The Calamarina that have been investigated have one lung. Among Colubrina and Glyphodonta, there are great variations. All the Coronellæ of Schlegel possess, according to Schlegel, a single lung. I find the lung single in *Rhachiodon scaber* [*Dasypeltis*]. *Tropidonotus natrix* [*Natrix vulgaris*] has a very small rudiment of a second lung. *Coluber* [*Spilotes*] *variabilis* possesses, according to Schlegel, the rudiment of a second lung. According to the statement of Meckel, this rudiment is common in Coluber. The Xenodons have, according to Schlegel, a single lung (*X. severus* and *X. rhabdocephalus*). In Heterodon I find a rudimental second lung. The Lycodons, according to Schlegel, possess a single lung; as also do Psammophis and Homalopsis. In *Dendrophis colubrina* Schlegel found the rudiment of the second lung. In Dipsas, according to Schlegel, there are variations; but he states that *D. multimaculata, D. lævis* and *D. annulata* [*Sibon annulatum*], have but one lung. The Achrochordina have but one lung. Among Hydrophidæ I found in three species of Hydrophis the lung-sack simple. Meckel states that Platurus has a very small rudiment of a second lung. Among the remaining poisonous snakes there is an insignificant rudiment of the second lung in the Elapina and Crotalina; while the Viperina possess an entirely simple lung."

The absence of tangible external characters which furnish indications of affinity in the Ophidia is well known. The important characters to be found in the skeleton were mostly pointed out by Müller, and Duméril and Bibron examined and utilized the characters of the dentition. The

* *Zootomie der Amphibien*, p. 108.

characters derived from the skeleton define only the larger divisions; while those derived from the teeth are not sufficiently numerous and important, with some exceptions, to indicate all of the affinities of the genera. I think I have added materially to the means at our disposal for classifying the Ophidia, by a study of the hemipenis.* The criteria will however not be sufficient until the entire anatomy is worked out, and in the present paper I add what may be found by a study of the lungs. It seemed probable to me that an organ which presents so much variation, as above stated by Stannius, must furnish some important clues. My examinations embraced about one hundred and fifty species, which represent nearly all the leading types. The results are presented in the following pages. It will be seen that they correct the statements of Schlegel and Stannius in a number of important respects.

The snakes with rudimental posterior limbs (Peropoda), show in the character of their lungs, what they show in the rudimental limbs themselves, and in the hemipenis, the nearest relationships to the Lacertilia. They possess, with an exception to be noted later, two well-developed lungs, one of which is larger than the other. The smaller lung lies to the right side and ventrally, while the larger one lies to the left side and dorsally. In some species the dorsal and ventral relation is more pronounced than in others. In the Colubroidea the right or ventral lung is generally present, but of very much reduced proportions, the usual size being from two to five millimeters in length. It is connected with the other lung by a foramen which perforates the tracheal cartilage at a point a little beyond the apex of the heart, and opposite to the proximal part of the dorsal lung. It is sometimes connected to the dorsal lung by a short tube, in which cartilaginous half rings are seen in but two of the genera examined, viz., Heterodon and Conophis. The lumen of the rudimental lung may be lined by the same reticulate structure as is seen in the dorsal lung, or its walls may be smooth. In some Colubroidea the rudimental lung is absent, but such species are relatively few.

The dorsal lung may present proximally alongside of the trachea an auricle or pocket, and this is so developed in the genus Heterodon as to reach to the head, without communication with the trachea, other than that furnished by the normal portion of the lung. In the Solenoglypha, without exception, this extension of the dorsal lung is present, and extends to the head, and its lumen is continuous with the trachea throughout its length. The same structure exists in the genera Hydrus and Hydrophis; and also in the peropodous genus Ungualia, which differs besides from other Peropoda in having but one posttracheal lung. Finally the tracheal lung, as I shall call it, is distinct from the true lung in Platurus and in Chersydrus. In the former of these genera the trachea is not separate from the lumen; while in Chersydrus it is distinct. It, however, communicates with the cells of which the lung consists in this genus by a series of regularly placed foramina on each side. There is no lumen in the tracheal lung in

* *American Naturalist*, 1893, p. 477.

Chersydrus. In Typhlops we have a still further modification of the tracheal lung. It is without lumen, and is composed of coarse cells of different sizes. These have no communication with the trachea or lung that I can discover, nor any efferent orifice. It has occurred to me that this structure, which extends from the heart to the throat, may not be a pulmonary organ.

I have referred to the dorsal and ventral positions of the two lungs. The rudimental lung is to the right of the dorsal lung in the Colubroidea, but in the Ilysiidæ it is to the left. It is quite questionable which lung this rudiment in this family really represents. In the Typhlopidæ, the single lung is on the right side and extends from the heart to the liver. It has the position of the rudimental lung of the Colubroidea, and may represent it. I cannot decide this question without further material. In Glauconia there is but one true lung, and this is ventral in position, and originates to the right of the heart, so that in this genus also it may represent the rudimental lung of the Colubroidea. There is here no tracheal lung or organ.*

I now give a synopsis of the characters observed in the species examined.

## CATODONTA.

*Glauconia dulcis* B. and G. A single elongate right lung; no rudiment of left lung. No tracheal lung.

## EPANODONTA.

*Typhlops liberiensis* Hallow.; *T. reticulatus* L. A right lung which is not elongate; no rudimental left lung. A cellular body surrounding the trachea, and extending from the heart to the throat, without lumen or connection with the trachea or lung.

The presence of the tracheal lung (?) and the freedom of the maxillary bone are points of resemblance to the Solenoglypha!

## TORTRICINA.

### *Ilysiidæ.*

Two lungs, the ventral one to the left side of the middle line, rudimental, but lined with pulmonary tissue like the other lung, and less reduced than in the Colubroidea.

*Cylindrophis maculata* L. The right lung extends only to the liver.

*Ilysia scytale* L. The right lung is larger.

### *Rhinophidæ.*

*Rhinophis oxyrhynchus* Schn. One large left lung and very small (3 mm.) right lung; no tracheal lung. Contrary to the statement of Stannius above quoted, as in Colubroidea generally.

* Cf. Peters, *Reise nach Mozambique*, iii, p. 100, Pl. xivA, 1882.

ASINEA.

PEROPODA.

I. Two well-developed lungs of unequal size; no tracheal lung.

*Pythonidæ.*

*Python regius* Shaw; *P. molurus* Linn.; *P. spilotes* Lacep.; *Loxocemus bicolor* Cope.

*Boidæ.*

*Xiphosoma caninum* L.; *Epicrates cenchria* L.; *Chilabothrus inornatus* Rein.; *Boa constrictor* L.; *Eunectes murinus* L.; *Eryx johnii* Russ.

*Charinidæ.*

Besides the absence of coronoid and supra and postorbital bones, this family differs from the Boidæ in the fusion of the nasal bones into a single plate. *Charina bottæ* Blv.

II. One lung without rudiment of a second; a tracheal lung extending from true lung, with which it is continuous, to throat.

*Ungualiidæ.*

*Ungualia maculata* Bibr.; *U. melanura* Gray.

COLUBROIDEA.

I. Two well-developed but unequal functional lungs.

*Xenopeltidæ.*

*Xenopeltis unicolor*, Reinwt.

II. One functional lung only; the right rudimental lung sometimes possibly with limited function.

*Colubridæ.*

Lycodontinæ.

*Lycodon aulicus* L.; *Boaodon infernalis* Gthr.; *Uriechis microlepidotus* Pet.; *Stenorhina ventralis* D. and B.

Colubrinæ.

*Elopops modestus* Gthr.*; *Coronella girundica* Daud.; *Dianodon semicarinatus* Cope; *Ficimia olivacea* Gray; *Salvadora bairdii* Jan.; *Pityophis sayi* Hobr.; *Epiglottophis pleurostictus* D. and B.; *Spilotes corais* Cuv.; *S. pullatus* L.; *Coluber quadrilineatus* Pallas; *C. obsoletus* Say; *C. quadrivittatus* Holbr.; *Bascanium constrictor* L.; *B. flagellum* Catesby; *B. mentovarium* D. and B.; *Zamenis atrovirens* Shaw; *Z. korros* L.;

* Position uncertain; perhaps a Lycodontine.

*Cyclophis æstivus* L. ; *Drymobius pantherinus* Merr. ; *D. boddærtii* Seetz. ; *D. margaritiferus* Schl. ; *Crossanthera melanotropis* Cope ; *Herpetodryas carinatus* L.; *Leptophis præstans* Cope ; *L. mexicanus* D. and B. ; *L. smaragdinus* Boie. ; *Dendrophis picta* L. ; *Dasypeltis palmarum* Leach.

Dipsadinæ.

*Dipsas blandingii* Hallow. ; *Himantodes gemmistratus* Cope ; *Rhinobothyrum lentiginosum* Scop. ; *Trimorphodon biscutatus* D. and B. ; *Sibon septentrionale* Kenn. ; *Malpolon lacertinum* Wagl.; *Cladophis kirtlandii* Hall ; *Dryophis fulgida* Daud. ; *Passerita mycterizans* L.

Chrysopeleinæ.

*Chrysopelea ornata* Shaw.

Xenodontinæ.

*Catostoma badium* D. and B. ; *Farancia abacura* Holbr. ; *Abastor erythrogrammus* Daud. ; *Opheomorphus fuscus* Cope ; *Helicops angulatus* Linn. ; *H. baliogaster* Cope ; *Dromicus parvifrons* Cope ; *Halsophis leucomelas* D. and B. : *Xenodon rhabdocephalus* Wied. ; *X. angustirostris* Peters ; *Lystrophis dorbignyi* D. and B. ; *Heterodon nasicus* B. and G.; *H. platyrhinus* Latr. ; *Hypsirhynchus ferox* Gthr. ; *Uromacer oxyrhynchus* D. and B. ; *U. catesbyi* D. B. Right lung larger in *Uromacer*.

Scytalinæ.

*Hydrocalamus quinquevittatus* D. and B. ; *Erythrolamprus venustissimus* L. ; *E. fissidens* Gthr. ; *Oxyrrhopus plumbeus* L. ; *O. fitzingerii* Jan. ; *Conophis pulcher* Cope ; *C. sumichrastii* Cope ; *Manolepis nasutus* Cope ; *Jultris dorsalis* Gthr. ; *Philodryas viridissimus* L.; *P. olfersii* Licht.

Natricinæ.

Generally a proximal auricle or pocket. *Eutænia proxima* Say ; *E. sirtalis* L., s. s. *sirtalis, obscura* and *parietalis ; Natrix fasciata* L.; *N. rhombifera* Hallow.; *N. taxispilota* Holbr.

*Appendix to Colubridæ.*

In the African *Thrasops flavigularis* Hallow. the right (rudimental) lung measures 5 mm. The trachea is enormously expanded transversely, simulating a tracheal lung, but its inferior wall contains the tracheal cartilages which extend its entire width, and it contains no cells or trabeculæ. An artery with lateral branches extends its entire length, which is from the posttracheal lung to the throat. This character distinguishes this genus from Leptophis.

In the following species I found no trace of the right lung.

Colubrinæ. *Rhinochilus lecontei* B. and G.; *Cemophora coccinea* Blum.; *Ophibolus doliatus* L.; *O. getulus* L.; *Pityophis melanoleucus* Daud.

Xenodontinæ. *Halsophis angulifer* D. and B.; *H. vudii* Cope.

Leptognathinæ. I propose this subfamily as distinct from the Xenodontinæ, on account of the presence of a large tracheal lung which is continuous with the normal lung, and with the trachea, and extends to the throat. *Leptognathus nebulatus* L.; *L. garmanii* Cope.

Scytalinæ. *Tachymenis strigatus* Gthr.; *Phalotris lemniscatus* D. and B.; *P. tricolor* D. and B.; *Erythrolamprus bipunctatus* Gthr.

Natricinæ. *Cerberus boæformis; Pseudaspis cana* L.

*Acrochordidæ.*

*Chersydrus granulatus* Merr. In this species the heart is at the middle of the length of the body, and the normal lung is posterior to it, extending nearly to the vent. No rudimental lung. A tracheal lung, composed of coarse cells and without lumen, extends from the heart to the head, and is discontinuous with the true lung. The trachea is closed, but communicates with the tracheal lung by a series of symmetrical pores on each sides

*Najidæ.*

One lung and a rudiment; no tracheal lung. *Pseudechis porphyriacus* Shaw; *Diemenia reticulata* Gray; *Naja tripidians* L.; *Bungarus semifasciatus* Kuhl.

*Elapidæ.*

No rudimental nor tracheal lung. *Elaps lemniscatus* L.; *E. fulvius* L.; *E. corallinus* L.; *E. multifasciatus* Jan.

*Hydrophidæ.*

I. One lung and no rudiment, continuous with tracheal lung, which extends to head.

*Hydrophis hardwickii* Gray (a slight constriction between tracheal and posttracheal lungs); *H. elliotii* Gthr.; *Hydrus bicolor* Daud.

II. A rudimental right lung connected with the left lung, which is separate from the large tracheal lung.

*Platurus laticaudatus* L.

SOLENOGLYPHA.

A tracheal lung, continuous with the normal lung.

*Causidæ.*

No rudimental lung.

*Causus rhombeatus* Licht.

*Dendraspididæ.*

No rudimental lung.

*Dendraspis polylepis* Gthr.

*Viperidæ.*

No rudimental lung.
*Clotho arietans* L.

*Crotalidæ.*

I. No rudimental lung.
*Bothrops lanceolatus* L.; *Ancistrodon piscivorus* Lacep.; *Crotalophorus catenatus* Raf. ; *Crotalus adamanteus* Beauv.; *C. confluentus* Say.
II. With a rudimental right lung.
*Bothrops pictus* Tsch.; *B. erythrurus* Cant. ; *Teleuraspis schlegelii* Berth.; *Ancistrodon contortrix* L.; *Crotalus horridus* L.

## THE SYSTEMATIC VALUE OF THE PULMONARY CHARACTERS.

I have no doubt of the propriety of the separation of the Ungualiidæ from the other Peropoda, on account of its pulmonary characters. Nor is there any doubt in my mind of the necessity of the separation of the Leptognathinæ from the Xenodontinæ, for similar reasons. The genus Heterodon differs very much from the Xenodontinæ, in the possession of an enormous diverticulum of the lung, but as it is not present in the allied genus Lystrophis Cope, its wider distinction may be a questionable proceeding. The very marked characters of the genus Chersydrus characterize the family, as well as the osteological characters. It remains to be seen whether the family I termed the Nothopsidæ, but which Boulenger unites with the Chersydridæ, agrees with it in pulmonary characters. The remarkable tracheal lung or gland distinguishes the Epanodonta from the Catodonta, emphasizing that observed in the osteology of the skull. The peculiar form and relations of the maxillary bone in this group resemble those of the Solenoglypha, and there may be some possible connection between the groups. The tracheal body may be a degenerate tracheal lung, such as that division possesses.

The value of the rudimental right lung as a character of the Colubroidea is increased by my investigations. In only two genera have I found it present or absent, viz., Halsophis and Pityophis. I am not sure but that I may yet find it in the *P. melanoleucus*, where I have failed hitherto, but I am sure that it is present in some species of Halsophis and wanting in others. A natural group of American Colubrinæ, appears to be characterized by its absence, viz., Rhinochilus, Cemophora and Ophibolus ; all genera with an entire anal shield. The development of cartilages in the bronchial foramen or tube of the rudimental lung is not a constant character. I found it in one *Heterodon platyrhinus* and not in another ; it is present in *Conophis pulcher*, but absent in *C. sumichrastii.*

The rudimental lung is often concealed from view and difficult to discover. The best test of its presence is the foramen which connects it with

the trachea, which will generally be found piercing the cartilage of the latter near the apex of the heart. The rudimental organ may then be found by inserting a bristle, and observing its destination through the more or less transparent tissues. In but one instance have I found a rudimental lung without a connecting foramen, viz., in the Mexican *Ficimia olivacea*. On the other hand, the foramen may terminate in a small blind sac.

The pulmonary characters may be determined without much dissection. The position of the heart must be first ascertained, and a longitudinal median incision made in the abdominal wall. In all forms except the Epanodonta and Catodonta, the trachea will be found passing to the left side of the heart, and entering the lung near its apex. By splitting the trachea, not too near its abdominal border, on turning the free margin upwards as the snake lies on its back, the *foramen bronchiale* will be seen and its lumen can be explored. The trachea is concealed by the œsophagus, which must be drawn to the left side of the body in order to make the examination. The examination of the tracheal lung requires the division of the abdominal wall further towards the head.

## EXPLANATION OF PLATES.

The figures variously reduced ; the heart and liver are turned over to show the trachea and lungs.

### Plate XI.

*Typhlops liberiensis* Hallow.

### Plate XII.

*Charina bottæ* Blv.

### Plate XIII.

*Chersydrus granulatus* Merr.

### Plate XIV.

*Coluber quadrivittatus* Holbr.

### Plate XV.

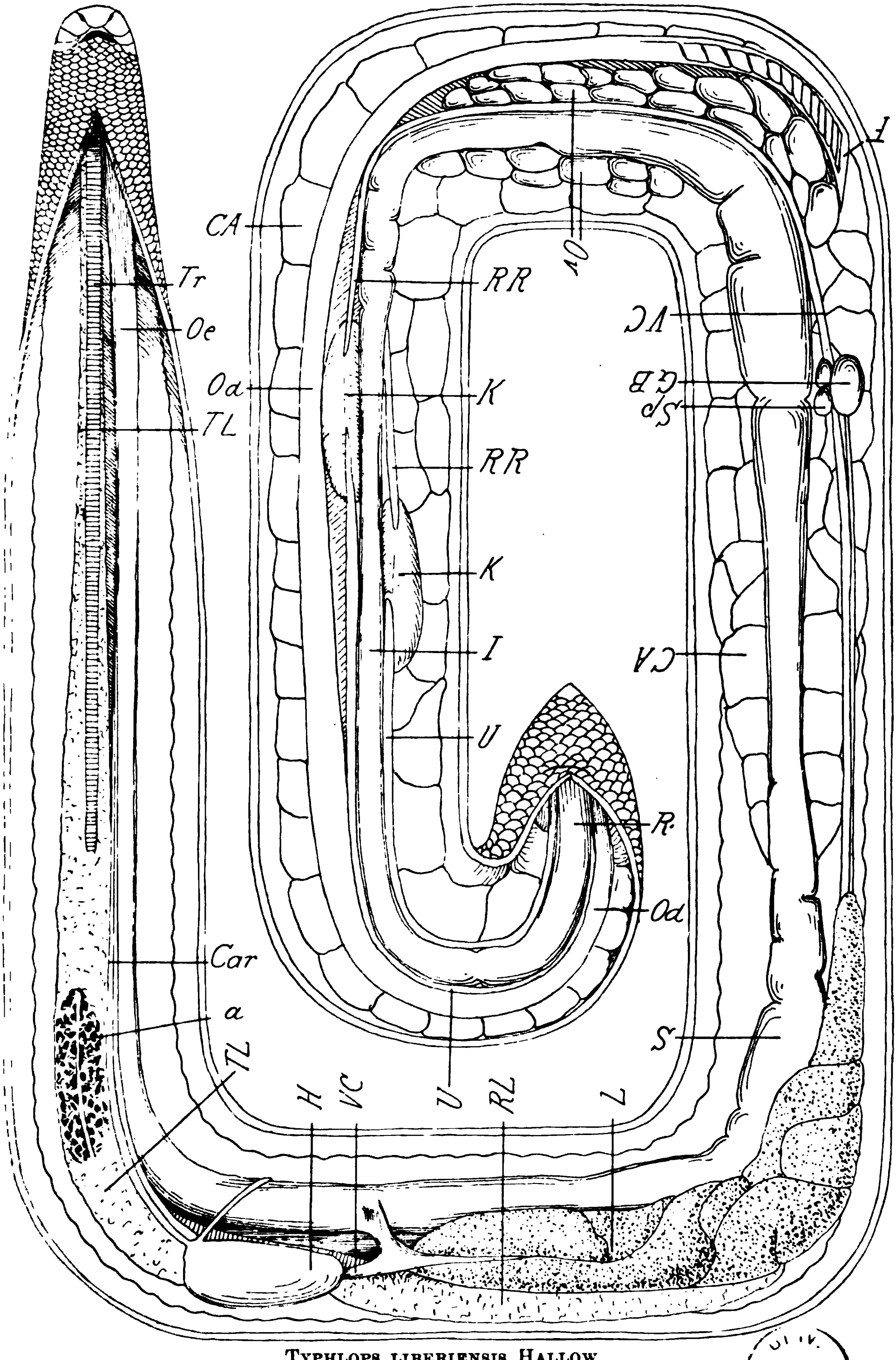
*Heterodon platyrhinus* Latr.

### Plate XVI.

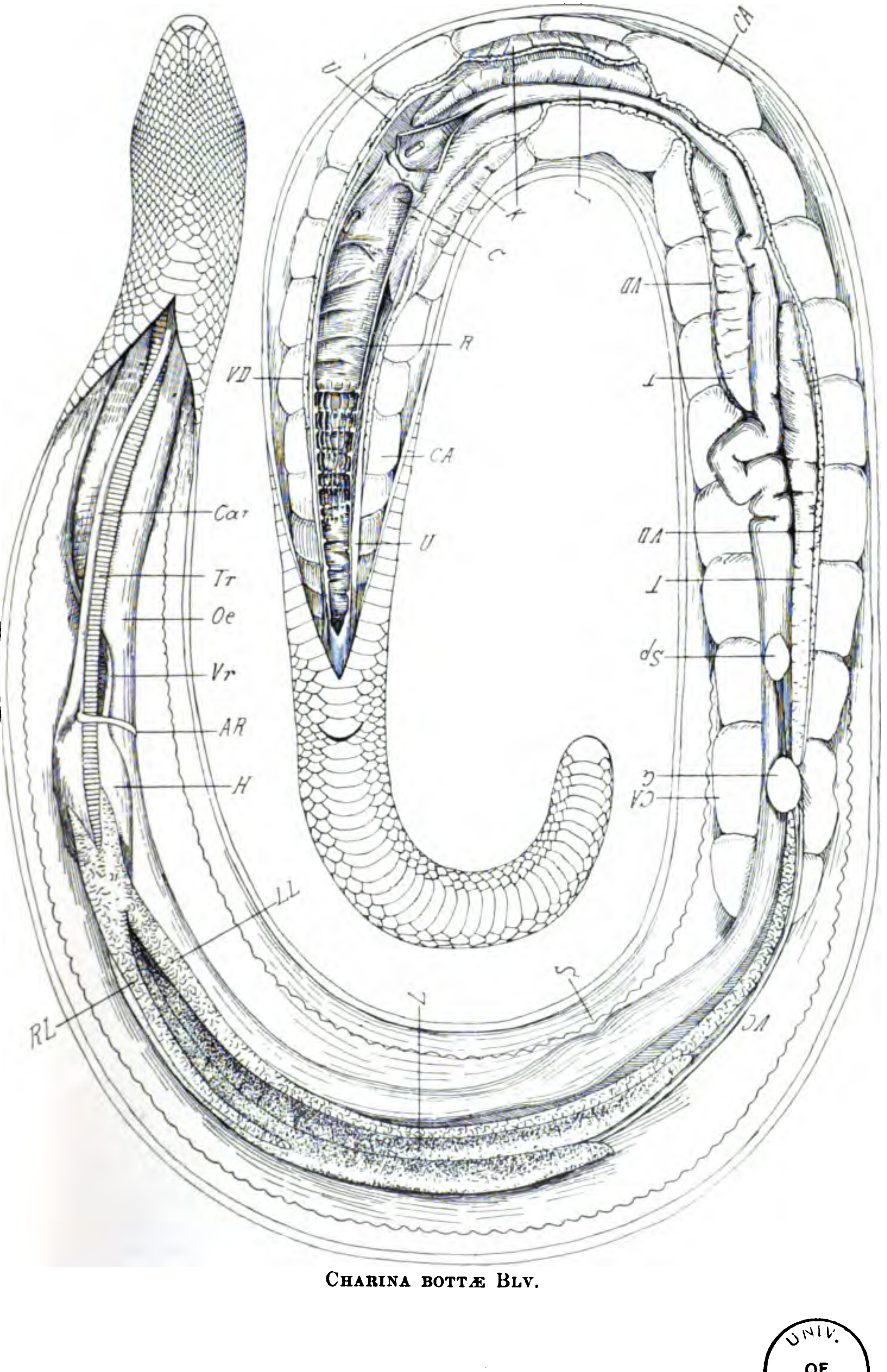
*Crotalus confluentus* Say.

### Lettering.

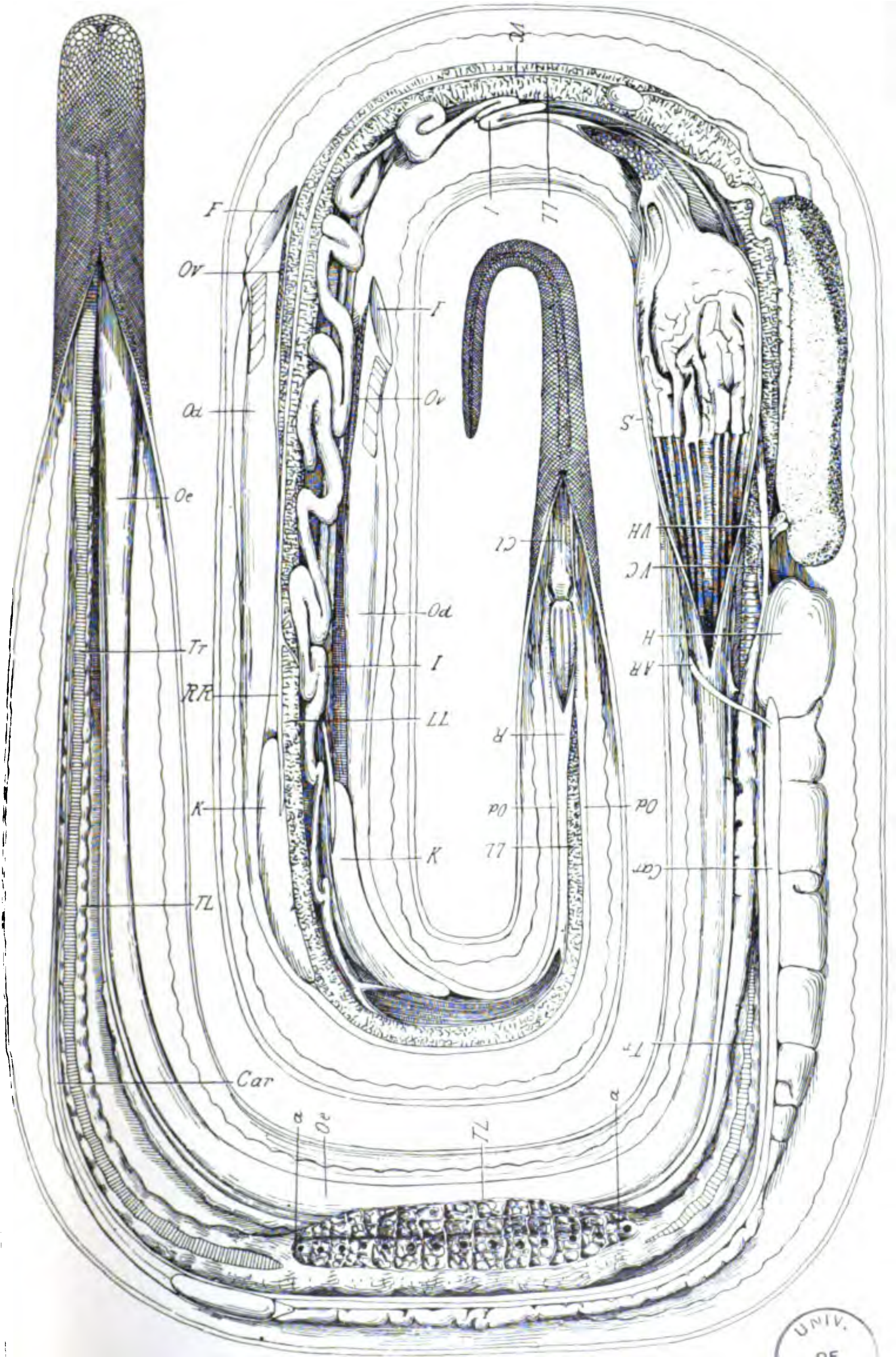
*Œ*, Œsophagus ; *St.*, Stomach ; *I.*, Intestine ; *R.*, Rectum ; *C.*, Cœcum ; *Tr.*, Trachea ; *R. L.*, Right lung ; *L. L.*, Left lung ; *T. L.* Tracheal lung ; *B. F.*, Bronchial foramen ; *L.*, Liver ; *G.*, Gall bladder ; *K.*, Kidney ; *U.*, Ureter ; *T.*, Testis ; *V. D.*, Vas deferens ; *Ov.*, Ovary ; *Od.*, Oviduct ; *V.*, Vagina ; *F.*, Fontanelle ; *C. A.*, Corpus adiposum ; *H.*, Heart ; *A. R.*, Aorta root ; *Car.*, Carotid ; *J.*, Juglar vein ; *V. C.*, Vina cavi.



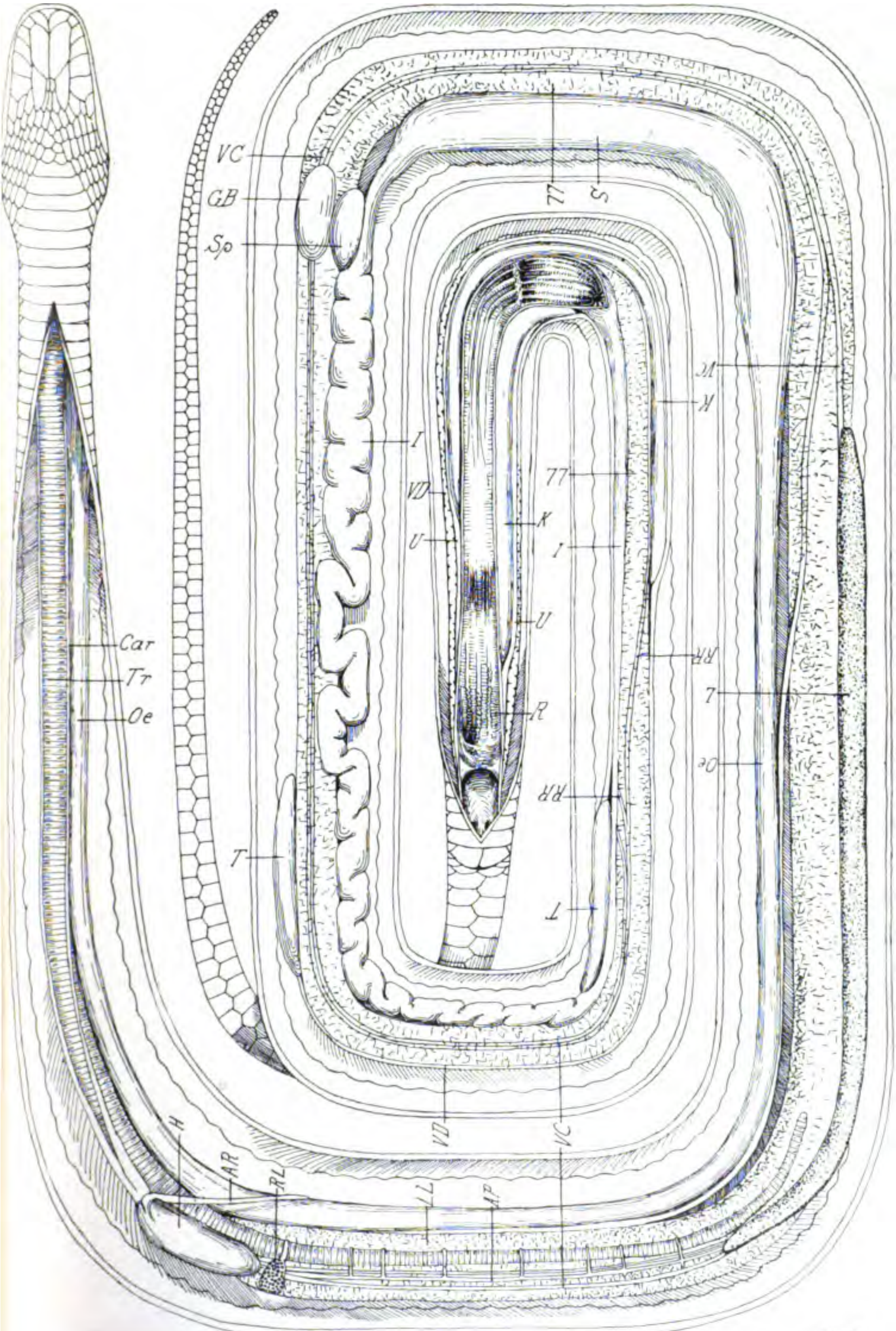

TYPHLOPS LIBERIENSIS HALLOW.



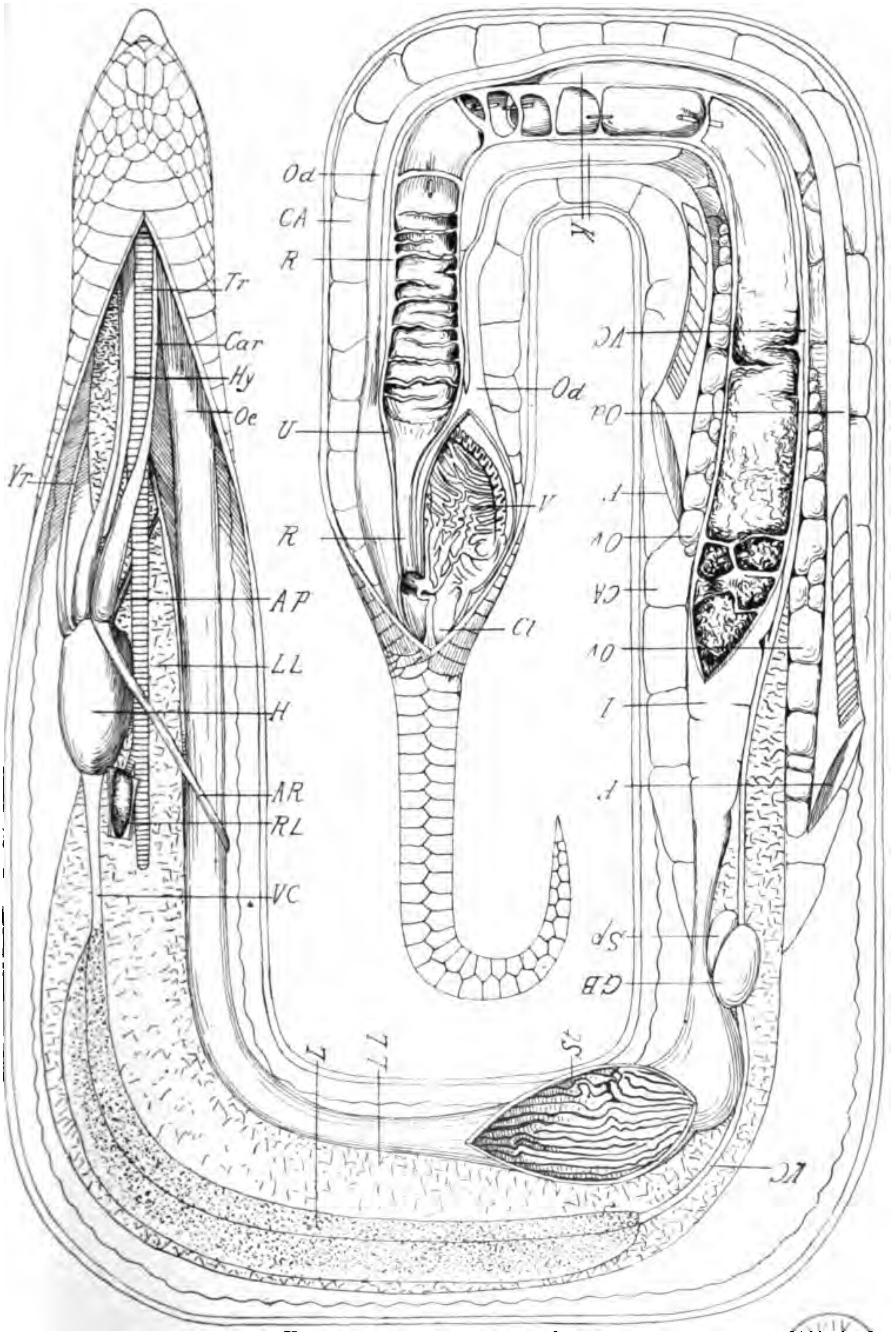

CHARINA BOTTÆ BLV.




Chersydrus granulatus Merr.




COLUBER QUADRIVITTATUS HOLBR.




HETERODON PLATYRHINUS LATR.

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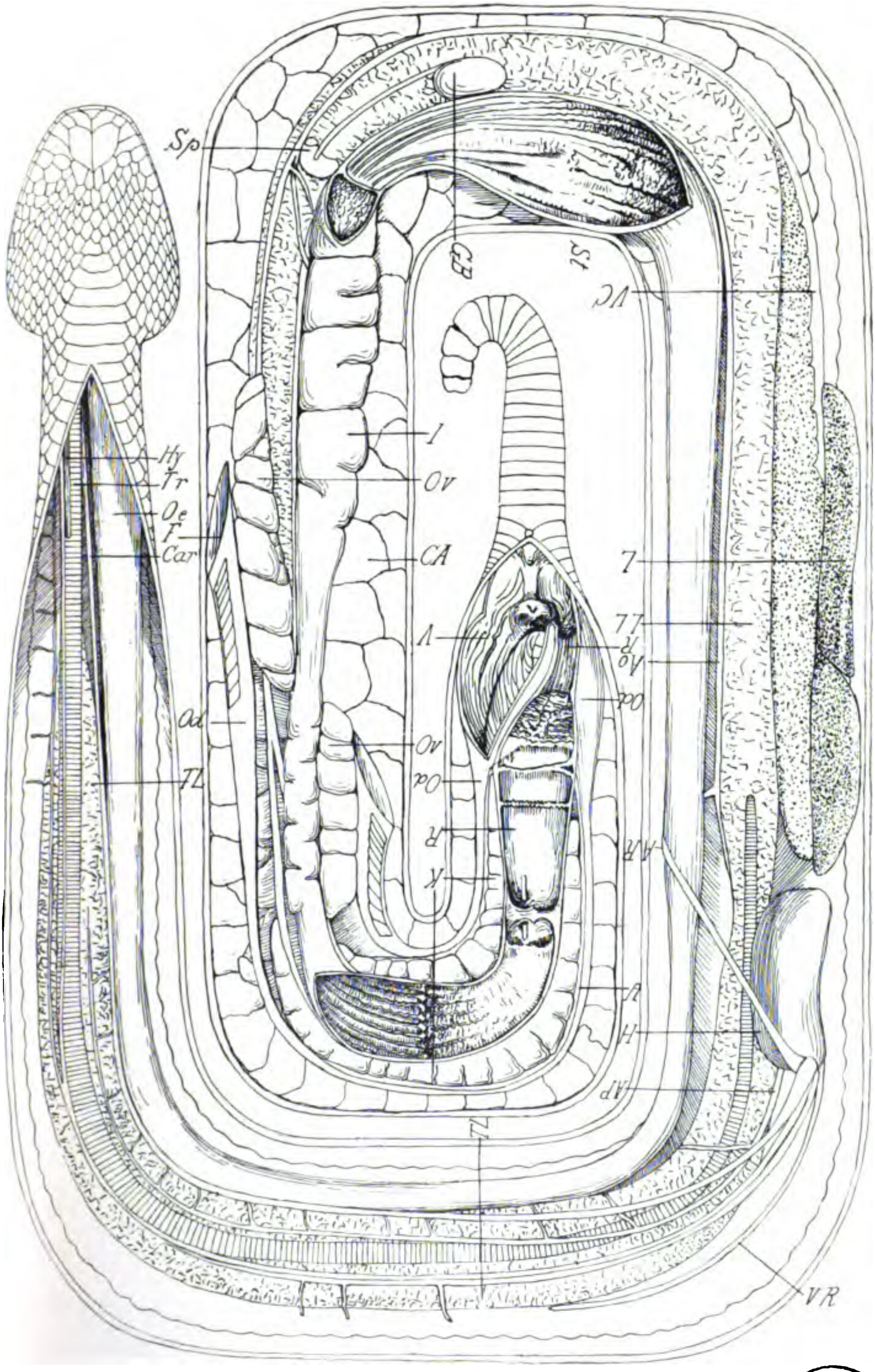
Vol. XXXIII, No. 145. Plate XVI.




Crotalus confluentus Say.

# *A Comparative Study of the Chemical Behavior of Pyrite and Marcasite.*

*By Amos Peaslee Brown.*

*(Read before the American Philosophical Society, May 18, 1894.)*

While much has been done in the way of investigating the chemical properties and constitution of the various artificial chemical compounds, comparatively little attention has been paid to the constitution of the naturally occurring chemical compounds. The carbon compounds, for instance, have in an immense number of cases been investigated with sufficient exactness to allow of our expressing their constitution by means of structural formulæ, but to how many minerals, aside from the simplest compounds, can we assign structural formulæ that are based on any knowledge that we possess of their reactions? It is true that much has been done in the way of the artificial production of minerals, and some knowledge of the constitution of certain minerals has been arrived at by a study of their decomposition products, but very little in comparison to the extent of the field. There are probably several reasons for this neglect of the study of the chemical properties and constitution of minerals, as want of homogeneity in the minerals themselves, difficulty of procuring or separating pure material for investigation, and similar difficulties which do not so frequently occur with artificial compounds. It thus happens that mineral chemistry is not as much studied as it deserves to be. Certain groups of minerals have, however, received some attention; for instance, Prof. F. W. Clarke has been carrying on a very interesting series of investigations on the constitution of certain silicates which have been productive of most valuable results. The natural sulphides, sulpharsenides and sulpho-salts present some very interesting problems in regard to their constitution, and it was with a view of adding to our knowledge of the chemical behavior of two of these sulphides that I undertook the series of investigations about to be described.

The compound $FeS_2$ is found in nature in two well-known forms—the one Pyrite (the isometric mineral) and the other Marcasite (the orthorhombic mineral). Since the separation of the two names from the general term, pyrites, it has been recognized that the orthorhombic form is lighter in color and also of lower specific gravity than the isometric form. From early times, also, the greater tendency of "white pyrites," or marcasite, to decompose in the air was well known.

Pyrite, the form which resists atmospheric weathering most thoroughly, is of a bright brass-yellow color and metallic lustre, breaking with an uneven conchoidal fracture, but bright on the surface of fracture. It crystallizes in the isometric system in forms showing generally pentagonal hemihedrism. Its specific gravity ranges from 4.8 to 5.2, averaging somewhat over 5. The brass-yellow crystals are generally quite unaltered in the air.

Marcasite, on the other hand, has a pale greenish or grayish yellow color, an uneven fracture, which shows a somewhat fibrous structure, and generally but little lustre on the surface of fracture. It crystallizes in the orthorhombic system, very commonly in twins or radiated fibrous masses. It is not very permanent in moist air, but readily decomposes and largely into $FeSO_4$. The chemical formula of either form, calculated from quantitative analyses, is the same, $FeS_2$ or $Fe = 46.67\%$, $S = 53.33\%$.

The chemical study of these two minerals has been mainly confined to the formation of one of them artificially and to a few experiments on their relative decomposability. Pyrite has been made artificially in a number of ways; marcasite has not as yet been formed artificially.* In 1836, Wöhler† produced cubes and octahedra of pyrite by subjecting a mixture of ferric oxide, flowers of sulphur and ammonium chloride to a temperature a little above the volatilizing point of the ammonium chloride. The resulting mass was washed to isolate the crystals from the accompanying pulverulent matter. Stanislas Meunier‡ modified this method by mixing equal parts of ferrous carbonate and sulphur and heating in glass tubes over a moderate flame. When the excess of sulphur has been driven off, there remains a black powder containing a considerable percentage of cubes of pyrite. Dana§ states that pyrite may be made "by slow reduction of ferrous sulphate in presence of some carbonate." Baubigny‖ produced $FeS_2$ as a crystalline crust by acting on metallic iron by a solution of $SO_2$ in water ($H_2SO_3$) in closed tubes and at a temperature of 200°. As neither this experiment nor the one immediately preceding it shows that the crystals were isometric, it is possible that both of them may be marcasite. Henri Saint Claire Deville¶ produced cubes of pyrite by melting a mixture of potassium sulphide ($K_2S$) and iron sulphide ($FeS$) in presence of excess of sulphur. This reaction, if correct as to the *cubical* product, is a remarkable one, as I should rather expect marcasite to result under such conditions. Senarmont** produced $FeS_2$ by decomposing a salt of iron by an alkaline sulphide at an elevated temperature in sealed glass tubes. The product was an amorphous black powder, not altering on exposure to air and not attacked by hydrochloric acid. This may have been pyrite, as marcasite is readily decomposed by moist air. Rammelsberg,†† in 1862, made $FeS_2$ pseudomorphs after ferric oxide ($Fe_2O_3$) by passing a current of hydrogen sulphide over it at a temperature between 100° and a red heat. The product of this reaction would likely be pyrite.

In nature it would seem that in most cases the sulphide of iron first

*Doelter, *Zeit. für Kryst.*, xi, 31, 1885; cf. Dana, *Syst. Min.*, 1892.

†*Pogg. Ann.*, xxxvii, p. 238.

‡*Les Méthodes de Synthèse en Minéralogie*, S. Meunier, 1891.

§J. D. Dana, *System of Mineralogy*, edition of 1868, p. 64.

‖S. Meunier, *Synth. Min.*, p. 279.

¶Cited in *Dict. Chem.* of Wartz, by E. Wilm, article "Iron," T. i, p. 1114.

**S. Meunier, *Synth. Min.*, p. 285.

††*Jour. für Praktische Chemie*, T. lxxxviii, p. 266.

formed is FeS, but probably by action of a ferric salt, or carbonic acid ($H_2CO_3$), causing a loss in iron $FeS_2$ results, and this is almost always pyrite. On the other hand, where ferrous sulphate has been reduced by slow action of decomposing organic matter, the resulting sulphide seems to be generally marcasite, which if not in crystals may be recognized by its ready weathering to ferrous sulphate ($FeSO_4$). This compound may, however, in many cases, be a mixture of pyrite and marcasite, as much pyrite seems to be.* These several ways in which pyrite may be formed are of importance as indicating the condition of the iron in the compound, and will be referred to later on.

Equally important as bearing on the constitution of these sulphides are the observations that have been made as to their decomposition under atmospheric agencies. On exposing crystallized pyrite to atmospheric weathering it is generally found that but little, if any, change takes place even in a year's time, while crystallized marcasite, under the same conditions, shows a rapid weathering. The main product of the weathering of pyrite in nature is the compound limonite, $Fe_4O_3(OH)_6$, which occurs in large quantities in nature, evidently derived from pyrite. Its pseudomorphs after pyrite are very common. On the other hand, when marcasite weathers a very large percentage of ferrous sulphate ($FeSO_4$) is formed with a comparatively small percentage of limonite, unless the marcasite decomposes underground and under pressure, when limonite is largely produced.† Much of the excess of sulphur with marcasite is changed to sulphuric acid, but with pyrite much remains behind as sulphur. Some comparison of the rate of oxidation of these two minerals in the air is afforded by an examination of specimens in a collection. Here it will be found that most of the pyrite is unchanged, but nearly every specimen of marcasite will show tarnish if no other sign of oxidation, and often a considerable coating of oxide can be seen, or a white efflorescence of $FeSO_4$.

Chemical investigations of these two minerals have been mainly in the way of analysis, but some experiments have been made in the way of studying their relative behavior towards certain reagents. Before describing my experiments, it will be necessary to briefly mention some of these.

Both minerals are decomposed by a solution of silver nitrate and gold chloride, the decomposition taking place quite rapidly.‡ My experiments in this connection are mentioned later.

A. A. Julien § has shown that different samples of pyrite show a difference in their reaction with bromine vapor. His experiments consisted in exposing finely ground pyrite to the action of bromine vapor at the tem-

*Compare A. A. Julien, "Decomposition of Pyrite," *Ann. N. Y. Acad. Sci.*, Vols. iii and iv.

† Blum, *Pseudomorphosen*, 1843, pp. 197-199.

‡ S. Meunier, *Synth. Min.*, p. 309.

§ A. A. Julien, *Ann. N. Y. Acad. Sci.*, Vol. iv, pp. 151, 155.

perature of the air for twelve hours. The residue was extracted with dilute $H_2SO_4$, which removed the iron rendered soluble (bromide), and the iron was then determined in this solution. The percentage of iron that had dissolved varied from 2.48 to 15.20 per cent., although all samples tested are described as pyrite. He also tried the action of bromine in aqueous solution, but the reaction was too rapid to give any comparative results.

Much more important are the results obtained in the oxidation of these minerals by the electric current as conducted by Prof. Edgar F. Smith,* and it was the remarkable results that were then obtained that induced me to continue the study of the comparative reactions of these two minerals Smith found that a current which would completely oxidize the sulphur in marcasite in a given time would oxidize less than half of the sulphur in pyrite in the same time. This remaining sulphur was held very tenaciously, though the mineral was subjected to more powerful currents and longer continued action than in the case of marcasite or pyrrhotite. Finally, by adding an equal quantity of CuO, and using a more powerful current, all of the contained sulphur was oxidized. Previous to the addition of CuO but 21 or 22 per cent of the sulphur was oxidized. In concluding the article above referred to the author questions whether the crystalline form alone can make this difference in the action of the two minerals when under the influence of the current.

The two samples of pyrite and marcasite that I selected for the following study were chosen after considerable examination of material as being typical of the two forms of $FeS_2$. The pyrite was from the hematite mines of Elba. It is exceptionally pure and free from decomposition or tarnish. Before deciding on it finally pieces were ground and polished and then examined under the microscope with powers ranging from 50 to 200 diameters, in order to see if it contained any enclosures or varied in texture. It was perfectly homogeneous and showed no enclosures. It took a high polish. The crystals showed the combination of octahedron and pentagonal dodecahedron $O + \frac{\infty O 2}{2}$. Some of the crystals were coated in places with scales of hematite, but this was all carefully removed in breaking up material for experiment. The color was bright brass-yellow, the specific gravity was determined as 5.179. The marcasite was from the zinc mines of the Subcarboniferous of Joplin, Jasper county, Mo., finely crystallized in polysynthetic twinnings. The freshly broken crystals show a greenish yellow color, almost white, but they tarnish readily with bluish or brownish colors. No gangue was present, everything dissolving completely in nitric acid. This marcasite was examined with the microscope in the same way as the pyrite ; it did not take such a high polish on account of a fibrous structure, but no foreign matter was found with a power of 200 diameters. Its color was uniform throughout, showing that no pyrite was present. The specific gravity as determined was 4.844.

In preparing material for experiment only sufficient was ground for im-

*Jour. Franklin Inst., Vol. cxxx, pp. 152–154.

mediate use to avoid any chance of oxidation of the ground material; the stock samples of the two minerals broken to nut size were kept in stoppered bottles. The grinding of material was continued as long as grit appeared, but no bolting was resorted to.

As the experiments of Prof. Smith on oxidation by the electric current showed such remarkable results, my first experiments were on oxidation. As an oxidizing agent potassium permanganate ($KMnO_4$) was used, several strengths of which were tried for varying intervals of time with each mineral, and the amount of sulphur oxidized to sulphuric acid determined in the liquid by precipitating as barium sulphate. The object was to secure a complete series of results which would show the comparative rates of oxidation of the sulphur in the two minerals. Neutral aqueous solutions of the potassium permanganate were used, and the strengths of solution employed were $\frac{1}{100}$ normal, one per cent., three per cent. and five per cent.; the periods of oxidation extending over one, two, three, four and five hours, and the entire series being performed at ordinary temperatures and at 100°. As duplicate determinations were made in the majority of cases (I made about 130 determinations of su phur as barium sulphate), this work consumed a large amount of time and prevented as full a study of some other reactions of the two minerals as had been originally intended. The following are the detailed descriptions of my processes and results:

### Action of $\frac{1}{100}$ Normal Potassium Permanganate Solution at Ordinary Temperature.

These oxidations were performed as follows: Two-tenths of a gram of the finely powdered mineral was placed in a stoppered bottle of about 100 c.c. capacity, then 50 c.c. of the permanganate solution added and the contents of the bottle violently shaken to break up lumps. This shaking was repeated about every fifteen minutes while the oxidation lasted. The temperature of the room was at the same time recorded. As stated, the oxidation was continued for one, two, three, four and five hours with each mineral, making at least ten experiments necessary for each strength of solution. After the solution had acted for the required time it was rapidly filtered through asbestos with aid of the filter pump, the filtrate transferred to a beaker, 20 c.c. of concentrated hydrochloric acid added, and the whole heated until all manganese was reduced to manganous chloride. If not too acid the solution was then diluted to about 300 c.c. and the sulphuric acid precipitated as barium sulphate. When very acid, excess of hydrochloric acid was removed by evaporation or by adding ammonia, the ammonium chloride seeming to facilitate the precipitation. The precipitate was washed with hot water and then weighed. All precipitations were made at boiling temperature and digested hot for at least two hours, and then cold for at least twelve hours more before filtering. The filtrates from most of the cold tests were re-

duced with metallic zinc and titrated with permanganate, but no iron was found in the solution.

The two minerals did not present the same appearance when acted on by the oxidant. Pyrite retained its color and seemed as pulverulent as when the permanganate was added, but marcasite immediately on the addition of the reagent became coated with manganese dioxide, took on a brownish color, and showed a tendency to cake together and stick to the sides of the bottle, so that it was with difficulty dislodged. This tendency of the marcasite was more marked with stronger solutions of the permanganate and was doubtless the cause of much of the irregularity that will be noticed in the results. The reason for this difference in action of the reagent on the two minerals will be discussed later on.

The percentages of sulphur oxidized in the two minerals by this method are shown in the following table, where all results that were obtained are recorded. The figures show the percentages of sulphur oxidized, calculated on the basis of $FeS_2$ equal to one hundred per cent. It will be noted that the four-hour oxidation of marcasite shows a result that is less than the two-hour. This was due to caking of the mineral against the walls of the bottle, which prevented much of it from coming in contact with the solution. On the whole, this series was about the most satisfactory of the cold experiments with $KMnO_4$, the action of this dilute solution being less rapid and hence more even than that of the more concentrated solutions; naturally the action ceases with a certain dilution, and hence the four- and five-hour oxidations of pyrite are about equal.

*Table Showing the Relative Oxidation of Sulphur in Pyrite and Marcasite by a $\frac{1}{100}$ N. Solution of $KMnO_4$ at 22°.*

| Mineral. | 1-Hour. | 2-Hour. | 3-Hour. | 4-Hour. | 5-Hour. |
|---|---|---|---|---|---|
| Pyrite with $\frac{1}{100}$ N. solution $KMnO_4$ | .78 | 1.17 | 1.38 | 1.74 | 1.72 |
| Marcasite with $\frac{1}{100}$ N. solution $KMnO_4$ | 1.07 | 1.86 | 2.04 | (1.25) | 2.38 |

The curves formed by plotting these results on rectangular coördinates are shown in Pls. xvii and xviii. They are marked 22° $M_1$ for the marcasite and 22° $P_1$ for the pyrite.

## Action of 1 Per Cent. Potassium Permanganate Solution at Ordinary Temperature.

This and also the two following series were performed as described under $\frac{1}{100}$ normal solution above. At least two experiments were tried with each mineral in this and the two following cold oxidations, and whenever a result was notably higher or lower than its dupli-

cate a third or fourth was tried. The tendency of the marcasite to cake, noted in the previous series, became still more marked here, and is doubtless the cause of one of the four-hour oxidations (marked by parenthesis) being notably lower than the three-hour. Such a result is obviously incorrect. On the other hand, the result in the three-hour column which is placed in parenthesis is the highest obtained. This experiment was made at the same time as the one showing 1.93 per cent., but the room was very warm (25°), which may in part account for this high result. It will be noticed that the oxidation of the pyrite seems to stop at the three-hour trial, those following showing no appreciable increase. This is well seen in the graphic representation of these oxidations (Pls. xvii and xviii).

*Table Showing the Relative Oxidation of Sulphur in Pyrite and Marcasite by a 1 Per Cent. Solution of $KMnO_4$ at 22°.*

| Mineral. | 1-Hour. | 2-Hour. | 3-Hour. | 4-Hour. | 5-Hour. |
|---|---|---|---|---|---|
| Pyrite with 1 per cent. solution $KMnO_4$ cold. | 1.72<br>1.71 | 1.38<br>1.47 | 1.85<br>1.87 | 1.79<br>1.90 | 1.70<br>1.89 |
| Marcasite with 1 per cent. solution $KMnO_4$ cold. | 1.16<br>1.28 | 1.29<br>1.13 | 1.93<br>2.19<br>(3.92) | 1.95<br>(1.56)<br>2.69 | 2.01<br>2.15<br>2.55 |

## Action of 3 Per Cent. Solution of Potassium Permanganate at Ordinary Temperature.

The conditions of this series of experiments were the same as those of the last. The tendency of the results to fluctuate instead of showing a gradual progression is now very marked. One of the one-hour pyrite oxidations shows more sulphur oxidized than is shown by any other individual result of the series. No explanation can be offered for such a discrepancy as this. On the other hand, the high result shown in the three-hour oxidation is quite easily explained by the marcasite having been little, if any, caked in this experiment. The two low results of pyrite three hour and marcasite four-hour oxidations are readily explicable on the ground of caking of the material. As the barium sulphate was often determined several days after the oxidation was completed, it is obvious that no reliable notes could be made concerning the caking or non caking of the mineral in the permanganate. With this strength of solution it is evident, too, that the main action of the permanganate is complete at the end of one hour, notably in the case of the marcasite, and it is only when very vigorous agitation exposes fresh surfaces of the mineral to the action of the $KMnO_4$ that any further action can take place. We therefore see that marcasite in one hour gives up as much sulphur as in five hours, and this is very graphically shown on Pl. xvii.

*Table Showing the Relative Oxidation of Sulphur in Pyrite and Marcasite by a 3 Per Cent. Solution of $KMnO_4$ at 22°.*

| Mineral. | 1-Hour. | 2-Hour. | 3-Hour. | 4-Hour. | 5-Hour. |
|---|---|---|---|---|---|
| Pyrite with 3 per cent. solution $KMnO_4$ cold. | 1.65<br>(3.55) | 2.23<br>2.31 | 2.80<br>(1.58) | 2.47<br>2.62 | 2.81<br>2.28 |
| Marcasite with 3 per cent. solution $KMnO_4$ cold. | 2.72<br>2.87 | 2.17<br>2.33 | 2.87<br>(3.31) | 2.88<br>(1.89) | 2.83<br>2.77 |

Action of 5 Per Cent. Solution of Potassium Permanganate at Ordinary Temperature.

In this series, as in the last, the action, as far as pyrite was concerned, was practically complete at the expiration of the first hour, but in the case of the marcasite this point was not reached until probably the end of the second hour, and, in fact, in one case was progressive to the end. But one very great discrepancy is to be noted here in the three-hour column with marcasite. The low result in the next column is explained by caking.

*Table Showing the Relative Oxidation of Sulphur in Pyrite and Marcasite by a 5 Per Cent. Solution of $KMnO_4$ at 22°.*

| Mineral. | 1-Hour. | 2-Hour. | 3-Hour. | 4-Hour. | 5-Hour. |
|---|---|---|---|---|---|
| Pyrite with 5 per cent. solution $KMnO_4$ cold. | 2.39<br>3.15 | 3.03<br>3.15 | 3.22<br>2.32 | 2.89 | 2.79<br>3.24 |
| Marcasite with 5 per cent. solution $KMnO_4$ cold. | 2.10<br>2.52 | 3.06<br>3.76 | 3.82<br>(5.83)<br>2.77 | 3.16<br>(2.44) | 3.39<br>4.17 |

This series finishes the experiments at ordinary temperatures. In all of them the action was comparatively slight, not exceeding at most 10 per cent. of the contained sulphur in the mineral which would not be sufficient to show any marked difference between the two minerals as bearing on their constitution, if the constitution which seems to be indicated by subsequent experiments (to be presently described) is the true one.

The oxidations with potassium permanganate at a temperature of 100° were conducted by suspending the vessel containing the mineral and solution in boiling water. Both stoppered bottles and thin glass flasks closed with perforated corks were used for this series of experiments. The water was kept continually boiling and the bottles or flasks were immersed deep enough to cover that portion of them containing the permanganate. Six or eight oxidations were made at one operation. The

permanganate solution, after it had acted the required time, was treated as in the experiments conducted at ordinary temperatures described above. Much more active oxidation took place at this temperature (100°), but the tendency of the mineral to cake together was much more marked, and now this took place with pyrite as well as with marcasite. Moreover, the deposition of manganese dioxide in every case was now very great, causing often a stoppage of the oxidation until it could be dislodged. As these oxidation experiments had already occupied much time only one trial was now made at each concentration of solution for each hour from one to five, unless, as before, marked discrepancies occurred, when two or more trials were made. The series of results are hence not so regular as they would have been had more trials been made, these irregularities arising from the difficulties that have been mentioned, as well as from the fact that the dilute solutions soon became exhausted, and that all solutions suffered some evaporation, but some more than others, causing irregular strength with the same solution. Nevertheless, the results agree in kind with those obtained at ordinary temperature, but differ widely in degree. Whereas at ordinary temperature the greatest amount of sulphur oxidized in marcasite by the five-hour trial with 5 per cent. permanganate was 4.17 per cent., at 100° this became 16.36 per cent, or about four times as much.

ACTION OF $\frac{1}{100}$ NORMAL POTASSIUM PERMANGANATE SOLUTION AT 100°.

The results given in the following table show perhaps more strongly than either of the other series of experiments at 100° the effect of the different disturbing causes that have been mentioned. It especially shows the effect of caking of the pyrite, which now came in as an important disturbing factor. The result of this caking is shown in the three- and four-hour results with pyrite, both being very low. Marcasite, on the other hand, invariably caked and stuck to the bottom of the bottle, but as this was a constant source of error in this case, the results show a gradual and fairly even increase. Irregular results with marcasite were now largely conditioned by the evaporation of the solution or by the fact of whether the mineral was evenly caked over the inner surface of the vessel or concentrated in spots. The result of this latter way of caking will be better seen in some of the subsequent series of experiments.

*Table Showing the Relative Oxidation of Sulphur in Pyrite and Marcasite by a $\frac{1}{100}$ Normal Solution of $KMnO_4$ at 100° C.*

| MINERAL. | 1-HOUR. | 2-HOUR. | 3-HOUR. | 4-HOUR. | 5-HOUR. |
|---|---|---|---|---|---|
| Pyrite with $\frac{1}{100}$ N. $KMnO_4$ at 100° C. | 4.05 | 4.72 | 3 36 | 2.04 | 5.64 |
| Marcasite with $\frac{1}{100}$ N. $KMnO_4$ at 100° C. | 3.17 | 3.84 | 3.76 | 5.63 | 5.61 |

## Action of 1 Per Cent. Potassium Permanganate Solution at 100°.

The results of the oxidation shown in this series are chiefly remarkable as still further illustrating the action of the solution on the caked material, as shown in the four- and five-hour trials with pyrite and the four-hour trial with marcasite. This latter shows, too, the effect of having the caked mineral massed in one spot. With this exception, the marcasite oxidations are progressive and fairly uniform (the two hour trial falls somewhat below what it doubtless should be), but the pyrite shows a sharp fall in the four- and five-hour trials. The cause of this has been indicated. That the concentration of the solution by evaporation caused an increase in the action seems to be indicated by the result of the five-hour marcasite oxidation, but this is much more strongly marked in the 5 per cent. series in the case of pyrite, which will be referred to later on.

*Table Showing the Relative Oxidation of Sulphur in Pyrite and Marcasite by a 1 Per Cent. Solution of $KMnO_4$ at 100°.*

| Mineral. | 1-Hour. | 2-Hour. | 3-Hour. | 4-Hour. | 5-Hour. |
|---|---|---|---|---|---|
| Pyrite with 1 per cent. $KMnO_4$ at 100° C. | 6.03 | 6.98 | 8.38 | 6.11 | 6.88 |
| Marcasite with 1 per cent. $KMnO_4$ at 100° C. | 6.43 | 5.61<br>6.25 | 8.56 | 7.40 | 9.10 |

## Action of 3 Per Cent. Solution of Potassium Permanganate at 100° C.

The average results of this series of oxidations were very good, with the exception of two members of the series—the marcasite five-hour trial and the pyrite three-hour. This latter was repeated, but with a similar low result. Leaving these two out of account, the average results show a very fairly even rate of progression, which have been brought out in the diagram (Pl. xvii). It is evident from an inspection of the following table that the marcasite oxidations of the four- and five-hour trials were arrested by some disturbing influence.

*Table Showing the Relative Oxidation of Sulphur in Pyrite and Marcasite by a 3 Per Cent. Solution of $KMnO_4$ at 100° C.*

| Mineral. | 1-Hour. | 2-Hour. | 3-Hour. | 4-Hour. | 5-Hour. |
|---|---|---|---|---|---|
| Pyrite with 3 per cent. $KMnO_4$ at 100° C. | 5.52<br>(7.01) | 5.77<br>7.89 | 6.81<br>5.16 | 10.73 | 11.08 |
| Marcasite with 3 per cent. $KMnO_4$ at 100° C. | 5.25<br>5.50<br>(8.67) | 7.97 | 9.42 | 9.80 | 7 55 |

## Action of a 5 Per Cent. Potassium Permanganate Solution at 100° C.

This series was decidedly the most satisfactory of the experiments conducted at 100° and, with the exception of the two-hour oxidations, in case of each mineral shows a remarkably regular increase in the oxidation of the sulphur. It illustrates, too, in the case of the pyrite, the effect of the concentration of the solution due to evaporation. This causes a more rapid rise in the results after three hours' action, and notably between four and five hours. This rise is not so well seen from the table as from the plot of the results given in Pl. xvii. Here this rising of the curve after three hours is very marked as contrasted with the curve of the marcasite oxidations.

*Table Showing the Relative Oxidation of Sulphur in Pyrite and Marcasite by a 5 Per Cent. Solution of $KMnO_4$ 100°.*

| Mineral. | 1-Hour. | 2-Hour. | 3-Hour. | 4-Hour. | 5-Hour. |
|---|---|---|---|---|---|
| Pyrite with 5 per cent. $KMnO_4$ at 100° C.................... | 7.95 | 7.52 | 9.85 | 11.86 | 14.98 |
| Marcasite with 5 per cent. $KMnO_4$ at 100° C........... | 8.38 | 8.38 | 13.27 | 14.85 | 16.36 |

The graphic representation of the rate of oxidation of sulphur in these two minerals is plotted from the following tables, the first of which shows the average amounts of oxidation of sulphur compiled from the several small tables already given. In this compilation I have omitted a few of the results given in parentheses in the small tables as they are evidently incorrect, and would vitiate the averages. On the other hand, I have simply retained the parentheses of the small tables in certain cases where but one result was obtained. The second table, also compiled from the several small tables, shows for the experiments at ordinary temperature the result of selecting, wherever possible, such individual determinations as show a progressive increase in the oxidation. In this way more regular series of results are obtained. Inasmuch as the variations are so marked, this method of selecting results seems justified, at least for obtaining a comparison of the relative rates of oxidation of the sulphur in the two minerals. The results of Table i are plotted in Pl. xvii, and those of Table ii in Pl. xviii.

I. *Table Showing Average Relative Oxidation of Sulphur in Pyrite and Marcasite by Solutions of $KMnO_4$ at 22° and at 100°.* See Pl. xvii.

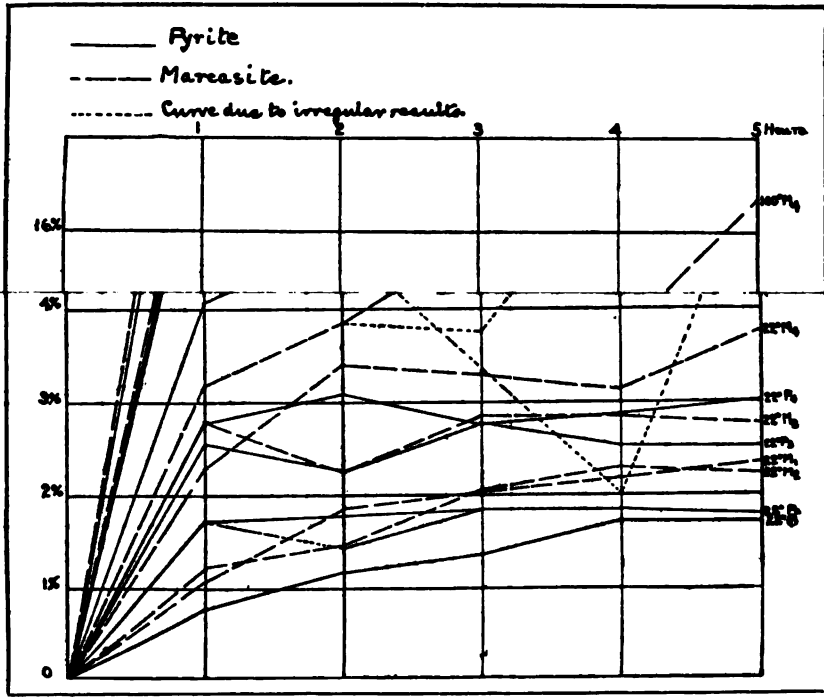
| Mineral. | 1-Hour | 2-Hour | 3-Hour | 4-Hour | 5-Hour | On Pl. |
|---|---|---|---|---|---|---|
| Pyrite $\frac{1}{100}$ N. cold | .78 | 1.17 | 1.38 | 1.74 | 1.72 | 22° $P_1$ |
| Marcasite $\frac{1}{100}$ N. cold | 1.07 | 1.86 | 2.04 | (1.25) | 2.38 | 22° $M_1$ |
| Pyrite 1 per cent. cold | 1.71 | (1.43) | 1.86 | 1.85 | 1.80 | 22° $P_2$ |
| Marcasite 1 per cent. cold | 1.22 | 1.21 | 2.06* | 2.32* | 2.24 | 22° $M_2$ |
| Pyrite 3 per cent. cold | 2.55 | 2.27 | 2.80* | 2.55 | 2.55 | 22° $P_3$ |
| Marcasite 3 per cent. cold | 2.80 | 2.25 | 2.87* | 2.88* | 2.80 | 22° $M_3$ |
| Pyrite 5 per cent. cold | 2.77 | 3.09 | 2.77 | 2.89 | 3.02 | 22° $P_4$ |
| Marcasite 5 per cent. cold | 2.31 | 3.41 | 3.30* | 3.16 | 3.78 | 22° $M_4$ |
| Pyrite $\frac{1}{100}$ N. 100° | 4.05 | 4.72 | 3.36 | 2.04 | 5.64 | 100° $P_1$ |
| Marcasite $\frac{1}{100}$ N. 100° | 3.17 | 3.84 | 3.76 | 5.63 | 5.61 | 100° $M_1$ |
| Pyrite 1 per cent. 100° | 6.03 | 6.98 | 8.38 | 6.11 | 6.88 | 100° $P_2$ |
| Marcasite 1 per cent. 100° | 6.43 | 5.93 | 8.56 | 7.40 | 9.10 | 100° $M_2$ |
| Pyrite 3 per cent. 100° | 6.26 | 6.83 | 6.81* | 10.73 | 11.08 | 100° $P_3$ |
| Marcasite 3 per cent. 100° | 6.47 | 7.97 | 9.42 | 9.80 | (7.55) | 100° $M_3$ |
| Pyrite 5 per cent. 100° | 7.95 | 7.52 | 9.85 | 11.86 | 14.98 | 100° $P_4$ |
| Marcasite 5 per cent. 100° | 8.38 | 8.38 | 13.27 | 14.85 | 16.36 | 100° $M_4$ |

II. *Table Showing Selected Results of the Oxidation of Sulphur in Pyrite and Marcasite by Solutions of $KMnO_4$ at 22°.* See Pl. xviii.

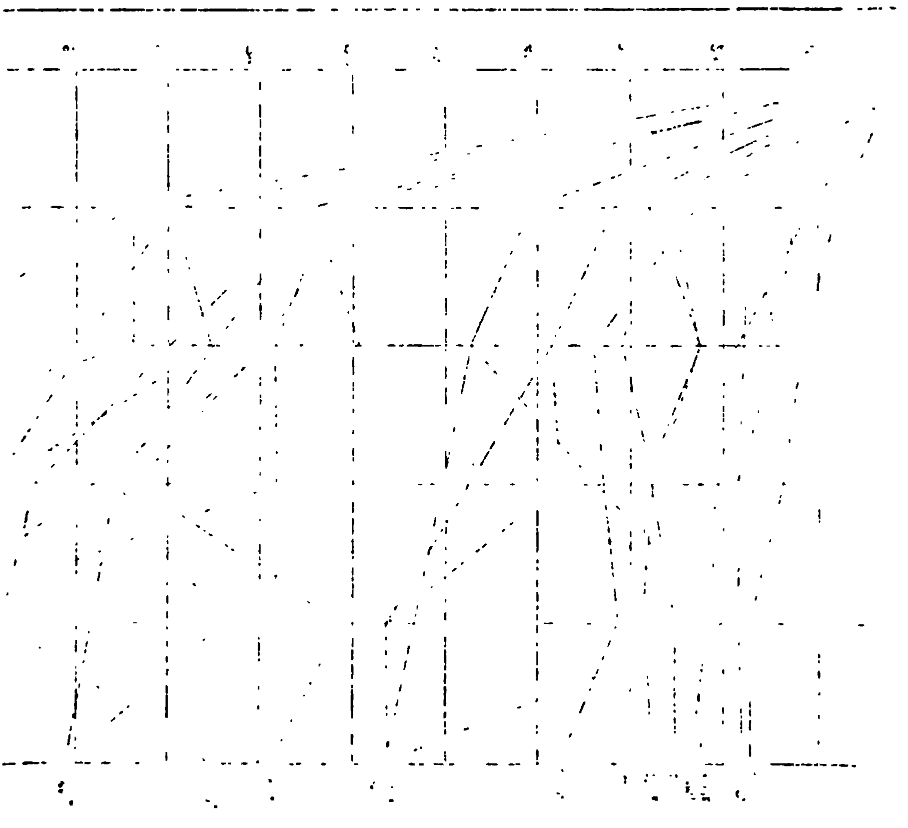
| Mineral. | 1-Hour | 2-Hour | 3-Hour | 4-Hour | 5-Hour | On Pl. |
|---|---|---|---|---|---|---|
| Pyrite $\frac{1}{100}$ N. cold | .78 | 1.17 | 1.38 | 1.74 | (1.72) | 22° $P_1$ |
| Marcasite $\frac{1}{100}$ N. cold | 1.07 | 1.86 | 2.04 | (1.25) | 2.38 | 22° $M_1$ |
| Pyrite 1 per cent. cold | (1.71) | 1.47 | 1.85 | 1.90 | 1.89 | 22° $P_2$ |
| Marcasite 1 per cent cold | 1.16 | 1.29 | 1.93 | 1.95 | 2.15 | 22° $M_2$ |
| Pyrite 3 per cent. cold | (1.65) | 2.31 | 2.80 | (2.62) | 2.81 | 22° $P_3$ |
| Marcasite 3 per cent. cold | (2.72) | 2.33 | 2.87 | 2.88 | 2.83 | 22° $M_3$ |
| Pyrite 5 per cent. cold | 2.39 | 3.03 | 3.22 | (2.89) | 3.24 | 22° $P_4$ |
| Marcasite 5 per cent. cold | 2.52 | 3.06 | 3.82 | (3.16) | 4.17 | 22° $M_4$ |

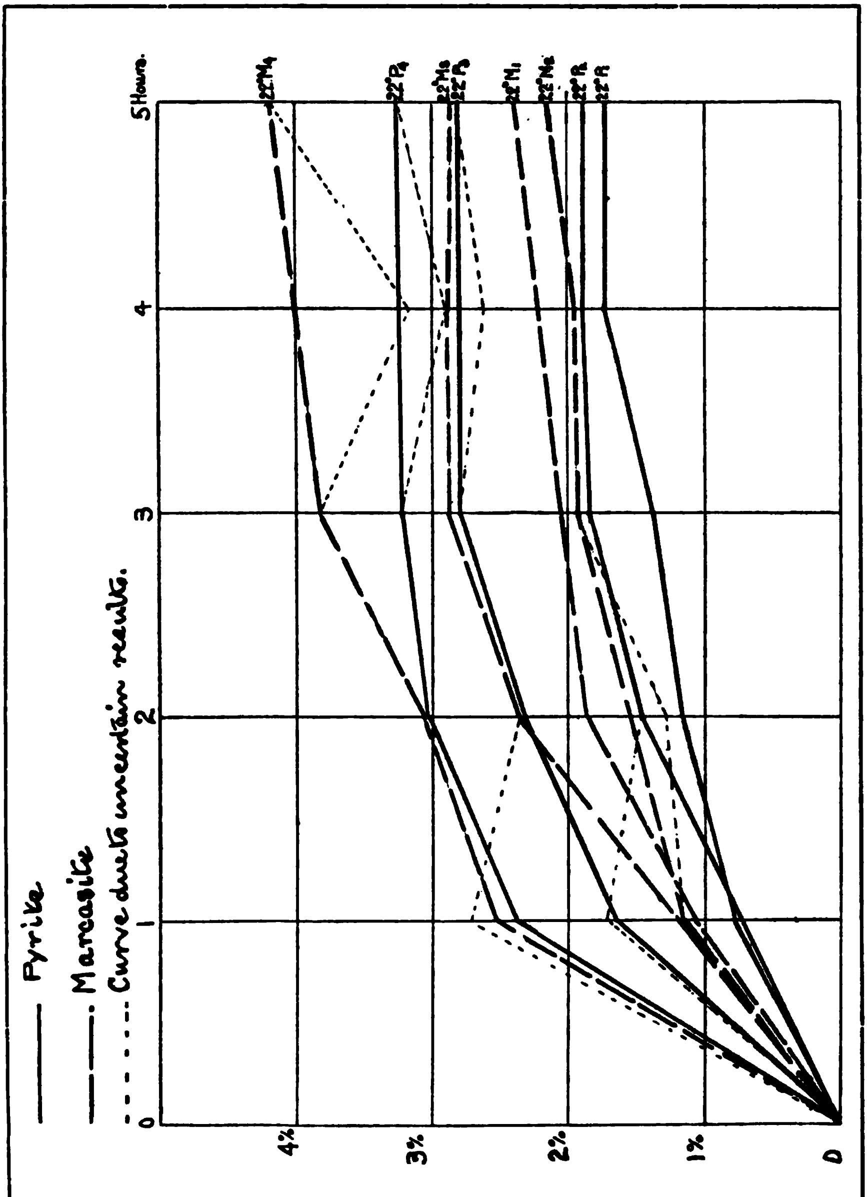
In plotting from these tables a vertical scale of one-half inch per one per cent. of sulphur oxidized and a horizontal scale of three-quarters inch per hour of oxidation have been employed. Wherever there was a drop in the results the gap has been bridged over by the main curve, thus making the curves as nearly as possible progressive, but the drop has been plotted in fine dotted lines. On examining these curves the points as to the relative rates of oxidation that have been mentioned are shown very graphically, the curve of the marcasite oxidation rising in each case above the corresponding one of pyrite, but both showing a similar form. Of these curves the $\frac{1}{100}$ normal solution cold and the 5 per cent. solution hot

* Obtained by omitting discordant results.



Pyrite
Marcasite.
Curve due to irregular results.
1
2
3
4
5 Hours
16%
4%
3%
2%
1%
0




Pyrite
Marcasite
Curve due to uncertain results.
5 Hours.
4
3
2
1
0
4%
3%
2%
1%
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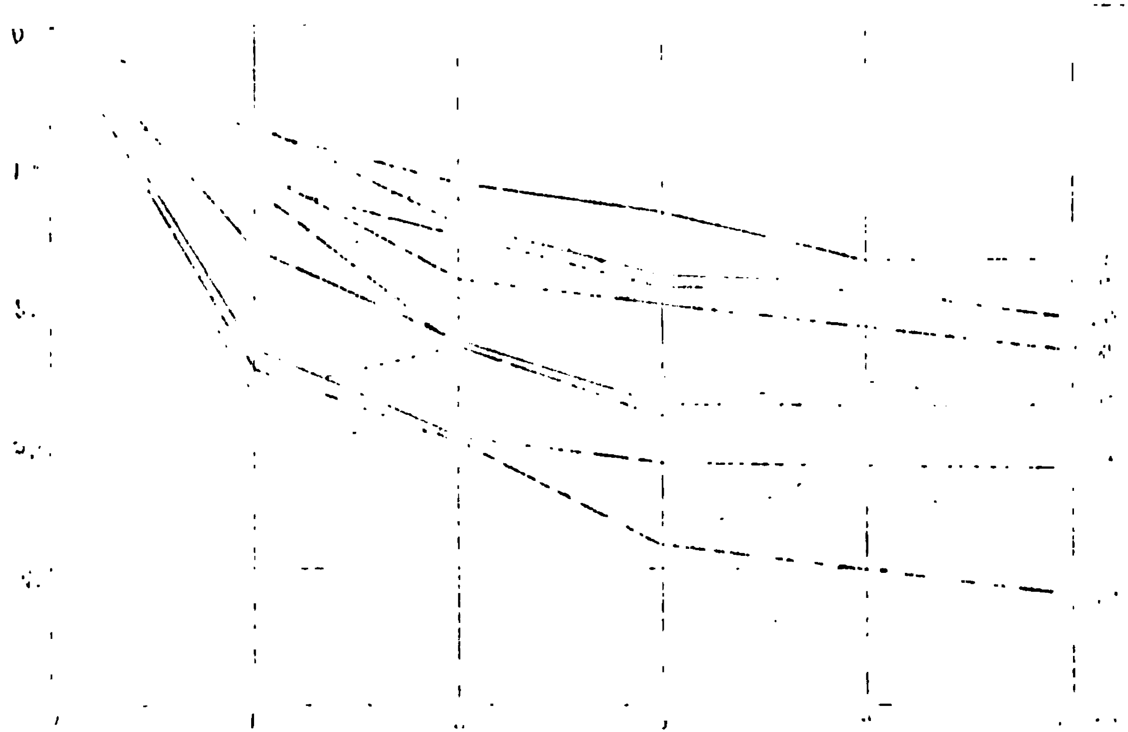

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| Pyrite heated at 310° for 1 hour in HCl, sulphur lost | 10.73 |
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About the same relative amounts were lost on heating for three and one half hours at 325°. The results thus obtained were as follows:

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Besides these two experiments, pyrite was heated for one hour at a red heat in a stream of the gas. A copious sublimate of ferrous chloride was found in the tube, with a trace of ferric chloride and sulphur. This time the loss was 46.47 per cent. of sulphur. It seems evident from these experiments that, as above stated, the iron in pyrite is in a condition that is more readily acted on by hydrochloric acid than is the iron in marcasite. It will be proved that the iron in marcasite is all ferrous, while part of that in pyrite is ferric, and this is probably the explanation of the above phenomenon. All of the iron in each case described above would form ferrous chloride ($FeCl_2$) on account of the reducing action of the hydrogen sulphide formed. Under the conditions of the above experiments, the critical point developed in the oxidation of pyrite was not reached, but it is not likely that it exists with this reagent, or if there be a critical point it is not 21 per cent. The thought suggested itself to me that perhaps some sulphur would be lost in pyrite if it were heated to 325° in a neutral atmosphere, and that this might account for the difference shown in the loss of sulphur in the two minerals. This proved not to be the case. Pyrite heated in this way in an atmosphere of nitrogen gave no appreciable loss after one hour at a temperature of 325°.

Instead of hydrochloric acid gas, the action was tried of ammonium chloride at temperatures up to 335° and in an atmosphere of nitrogen. Under these conditions the sulphur was combined as ammonium sulphide probably and did not exert such a reducing action on the iron. These experiments were conducted as follows: 0.2 gram of the finely pulverized mineral was mixed with 0.5 gram dry ammonium chloride and introduced (in a porcelain boat) into a glass tube. Test samples of $NaHSO_4 \cdot H_2O$ and $KClO_3$ in sealed tubes were used to regulate the temperature. All air was displaced in the tube by nitrogen and a slow current of nitrogen passed through the tube before heating. Under these conditions with marcasite, sulphur and ammonium sulphide were found sublimed in the tube along with ammonium chloride, and in the boat there was found much ferrous chloride without any ferric chloride, but in the case of the pyrite there was formed a large proportion of ferric chloride, which sublimed on the tube towards the end of the operation. The heating was conducted slowly in each case and continued until all ammonium chloride was sublimed frcm the boat, the temperature of 335° not being exceeded during this time. The entire operation lasted about twenty-five minutes in each case. Three trials of each mineral were made and with the same result in each case; with marcasite only ferrous chloride was found in the boat and no iron in the tube, pyrite always gave much ferric chloride and little ferrous. The amounts of sulphur removed are probably not very significant; they showed the following results:

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| Pyrite heated with $NH_4Cl$ lost sulphur | (*a*) | 7.02 |
| " " " " | (*b*) | 7.10 |
| Marcasite " " " | (*a*) | 9.50 |

The important point brought out in these experiments is that pyrite contains a large amount of ferric iron, while in marcasite the iron apparently exists in the ferrous condition. Some reducing action might, however, have taken place, due to the sulphides formed. The condition of the iron in the chlorides found in the boat and tube was very carefully tested by several reagents in each case, and there can be no doubt as to the correctness of the results as stated above.

The decomposition of the sulphides by metallic salts seemed to offer some hope of being productive of results that would show in a quantitative way the exact amounts of ferrous or ferric iron that are present in these two minerals. In this line, the action of gold chloride, silver nitrate and silver sulphate were tried in a qualitative way with both minerals. Of these, the first gave a ready decomposition with both, and produced both ferrous and ferric salts in each case. The silver nitrate gave a similar result. Silver sulphate acted very slowly and without any definite results.

The action of copper sulphate in neutral solution and under pressure was tried with very remarkable results. At the ordinary temperature and pressure the solution of this salt has little effect on either mineral, and the same is true of the solution at a boiling temperature, but under pressure the reaction is complete. The experiment was conducted as follows: 0.2 gram of the finely pulverized mineral was introduced into a stout glass tube, and 50 c.c. of a 10 per cent. solution of the salt, $CuSO_4 \cdot 5H_2O$, added, the air displaced with a pinch of $NaCO_3$ and a drop or two of $H_2SO_4$ (dilute), and a heavy seal made on the tube. The tubes containing the two minerals were heated for six hours in an autoclave to a temperature of about 200°. The contents of the tubes were found to contain no traces of undecomposed mineral, but there was a black, more or less flocculent precipitate in its place. This proved to be copper sulphide. The solution had not altered appreciably in appearance. The liquid contents of the tube were in each case transferred to a flask previously filled with $CO_2$ and with 10 c.c. dilute sulphuric acid in the bottom, the tube then rinsed with water and the amount of ferrous iron present titrated with freshly standardized potassium permanganate. In the case of marcasite this gave 18 c.c. $KMnO_4$ solution (this was two- or three-tenths of a cubic centimeter too much, on account of the difficulty in catching the end reaction). To correct this for the iron in the copper sulphate, a blank of 50 c.c. $CuSO_4$ solution, the same as used above with 10 c.c. dilute sulphuric acid, was titrated with the permanganate, giving 0.5 c.c. reduction. The factor of the permanganate was .0054 gm. Fe for 1 c.c. Making the correction for the reduction of 50 c.c. $CuSO_4$ solution, this gives 47.25 per cent. of iron in solution as against 46.67, the theoretical amount in $FeS_2$. No doubt if the end reaction had been more exact there would have been a still closer correspondence in the result.

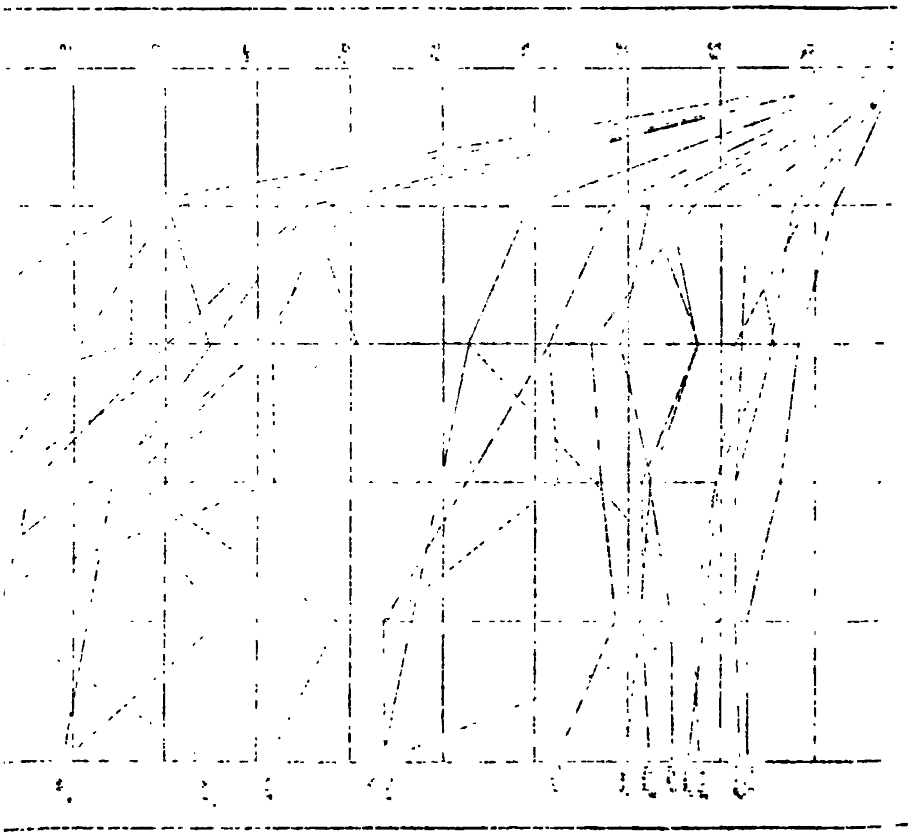
The tube containing the pyrite was treated in exactly the same manner, and gave a reduction of permanganate of 3.8 c.c. This time the end

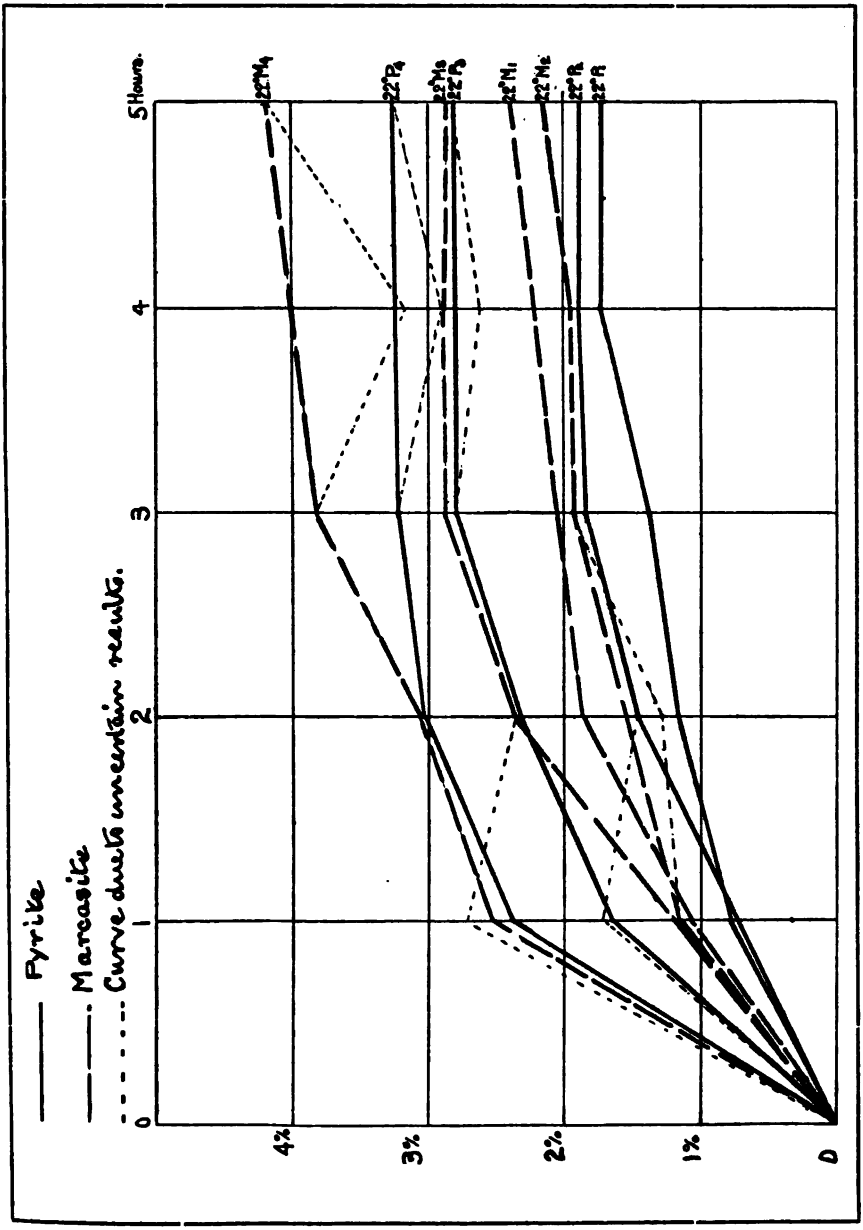
reaction was sharp and exact. Calculating the above to iron (after making correction for $CuSO_4$) this gives 8.91 per cent. of ferrous iron in pyrite. As the total iron is 46.67, this corresponds to 19.09 per cent. of the iron in the mineral, or almost exactly one-fifth. These experiments demonstrate in a positive manner the condition of the iron in the two minerals, and even show the exact amounts of each condition of the iron, ferrous and ferric.*

That marcasite should hence be more readily decomposed by oxidation than pyrite seems fully explained by the foregoing investigations, as it consists of $Fe''S_2$, an unsaturated compound. In this compound, sulphur must link to sulphur, or the compound have unsaturated bonds, and hence any element which would attack the sulphur would break up the compound. On the other hand, the iron is held to the sulphur by its full number of bonds, and any substance that has an affinity for iron could not so readily attack it in this condition. This would be true whether ferrous iron be considered here as $Fe_2$, with a valence of four, or as $Fe''$. That marcasite is $Fe''S_2$ is also indicated by its oxidation in the air into $FeSO_4$ mainly. Under these same conditions it will be noted that pyrite forms both ferrous and ferric compounds, as $FeSO_4$, but much more $Fe_4O_3(OH)_6$ and free sulphur. Marcasite, however, when decomposed by water under pressure (in nature) forms much limonite also, this being due no doubt to the oxidation being effected under pressure. This constitution explains also the fact that the oxidation of marcasite is continuous and complete, as shown by the current oxidations. It will be shown also that this constitution of pyrite that has been made out explains fully its action with the current. That marcasite is unsaturated is also indicated by the fact that it has not been made artificially or at any rate positively identified in any of the artificial $FeS_2$ that has thus far been made. If marcasite be a persulphide, as its formula would seem to indicate for a ferrous compound, none of the methods detailed above for making $FeS_2$ would be applicable in its case, unless perhaps the method of Deville might produce it. All of the other methods would probably produce ferric iron, at least in large part, and the resulting product would be pyrite.

The formula for pyrite derived from my investigations and expressing the relation of the two conditions of the iron in the simplest way is $4\,Fe^{iv}S_2 \cdot Fe''S_2$. This formula is also borne out by what we know of the formation of pyrite as given in the early part of this paper, and by such experiments as I have made on its decomposition, as well as the fact above alluded to that it, in oxidizing in nature, does not form much ferrous compounds but mainly ferric. And it also explains the fact that it is more stable as regards any element attacking its sulphur, for it is most probable that all the sulphur of the $Fe''S_2$ in its formula is linked to iron. I would propose the following structural formula, not as expressing the exact constitution of the compound, for of that we know nothing, but as an

*These results have been confirmed by experiments made during the past year in this laboratory, and not yet published.




Pyrite
Marcasite
Curve due to uncertain results.
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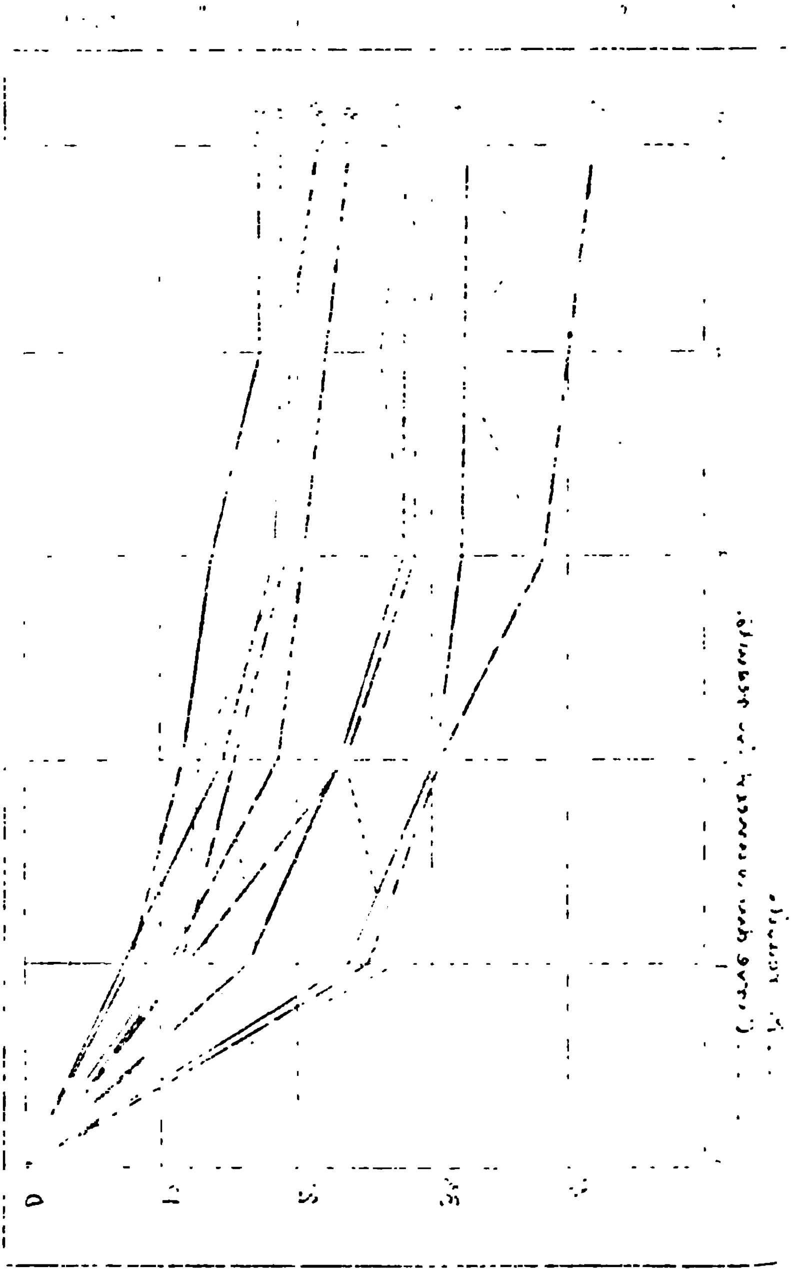

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| Marcasite " " " " " | 10.70 |

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| | | |
|---|---|---|
| Pyrite heated with $NH_4Cl$ lost sulphur | (*a*) | 7.02 |
| " " " " | (*b*) | 7.10 |
| Marcasite " " " | (*a*) | 9.50 |

The important point brought out in these experiments is that pyrite contains a large amount of ferric iron, while in marcasite the iron apparently exists in the ferrous condition. Some reducing action might, however, have taken place, due to the sulphides formed. The condition of the iron in the chlorides found in the boat and tube was very carefully tested by several reagents in each case, and there can be no doubt as to the correctness of the results as stated above.

The decomposition of the sulphides by metallic salts seemed to offer some hope of being productive of results that would show in a quantitative way the exact amounts of ferrous or ferric iron that are present in these two minerals. In this line, the action of gold chloride, silver nitrate and silver sulphate were tried in a qualitative way with both minerals. Of these, the first gave a ready decomposition with both, and produced both ferrous and ferric salts in each case. The silver nitrate gave a similar result. Silver sulphate acted very slowly and without any definite results.

The action of copper sulphate in neutral solution and under pressure was tried with very remarkable results. At the ordinary temperature and pressure the solution of this salt has little effect on either mineral, and the same is true of the solution at a boiling temperature, but under pressure the reaction is complete. The experiment was conducted as follows: 0.2 gram of the finely pulverized mineral was introduced into a stout glass tube, and 50 c.c. of a 10 per cent. solution of the salt, $CuSO_4 \cdot 5H_2O$, added, the air displaced with a pinch of $NaCO_3$ and a drop or two of $H_2SO_4$ (dilute), and a heavy seal made on the tube. The tubes containing the two minerals were heated for six hours in an autoclave to a temperature of about 200°. The contents of the tubes were found to contain no traces of undecomposed mineral, but there was a black, more or less flocculent precipitate in its place. This proved to be copper sulphide. The solution had not altered appreciably in appearance. The liquid contents of the tube were in each case transferred to a flask previously filled with $CO_2$ and with 10 c.c. dilute sulphuric acid in the bottom, the tube then rinsed with water and the amount of ferrous iron present titrated with freshly standardized potassium permanganate. In the case of marcasite this gave 18 c.c. $KMnO_4$ solution (this was two- or three-tenths of a cubic centimeter too much, on account of the difficulty in catching the end reaction). To correct this for the iron in the copper sulphate, a blank of 50 c.c. $CuSO_4$ solution, the same as used above with 10 c.c. dilute sulphuric acid, was titrated with the permanganate, giving 0.5 c.c. reduction. The factor of the permanganate was .0054 gm. Fe for 1 c.c. Making the correction for the reduction of 50 c.c. $CuSO_4$ solution, this gives 47.25 per cent. of iron in solution as against 46.67, the theoretical amount in $FeS_2$. No doubt if the end reaction had been more exact there would have been a still closer correspondence in the result.

The tube containing the pyrite was treated in exactly the same manner, and gave a reduction of permanganate of 3.8 c.c. This time the end

reaction was sharp and exact. Calculating the above to iron (after making correction for $CuSO_4$) this gives 8.91 per cent. of ferrous iron in pyrite. As the total iron is 46.67, this corresponds to 19.09 per cent. of the iron in the mineral, or almost exactly one-fifth. These experiments demonstrate in a positive manner the condition of the iron in the two minerals, and even show the exact amounts of each condition of the iron, ferrous and ferric.*

That marcasite should hence be more readily decomposed by oxidation than pyrite seems fully explained by the foregoing investigations, as it consists of $Fe''S_2$, an unsaturated compound. In this compound, sulphur must link to sulphur, or the compound have unsaturated bonds, and hence any element which would attack the sulphur would break up the compound. On the other hand, the iron is held to the sulphur by its full number of bonds, and any substance that has an affinity for iron could not so readily attack it in this condition. This would be true whether ferrous iron be considered here as $Fe_2$, with a valence of four, or as $Fe''$. That marcasite is $Fe''S_2$ is also indicated by its oxidation in the air into $FeSO_4$ mainly. Under these same conditions it will be noted that pyrite forms both ferrous and ferric compounds, as $FeSO_4$, but much more $Fe_4O_3(OH)_6$ and free sulphur. Marcasite, however, when decomposed by water under pressure (in nature) forms much limonite also, this being due no doubt to the oxidation being effected under pressure. This constitution explains also the fact that the oxidation of marcasite is continuous and complete, as shown by the current oxidations. It will be shown also that this constitution of pyrite that has been made out explains fully its action with the current. That marcasite is unsaturated is also indicated by the fact that it has not been made artificially or at any rate positively identified in any of the artificial $FeS_2$ that has thus far been made. If marcasite be a persulphide, as its formula would seem to indicate for a ferrous compound, none of the methods detailed above for making $FeS_2$ would be applicable in its case, unless perhaps the method of Deville might produce it. All of the other methods would probably produce ferric iron, at least in large part, and the resulting product would be pyrite.

The formula for pyrite derived from my investigations and expressing the relation of the two conditions of the iron in the simplest way is $4\,Fe^{iv}S_2 \cdot Fe''S_2$. This formula is also borne out by what we know of the formation of pyrite as given in the early part of this paper, and by such experiments as I have made on its decomposition, as well as the fact above alluded to that it, in oxidizing in nature, does not form much ferrous compounds but mainly ferric. And it also explains the fact that it is more stable as regards any element attacking its sulphur, for it is most probable that all the sulphur of the $Fe''S_2$ in its formula is linked to iron. I would propose the following structural formula, not as expressing the exact constitution of the compound, for of that we know nothing, but as an

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acid gas over the minerals at an elevated temperature. In these trials, 0.2 gram of the mineral was placed in a porcelain boat and heated in a glass tube in a strong stream of the gas. The sulphur in the series of experiments at the lower temperature was collected by passing the gas through bulbs containing Br + HCl; at the higher temperatures, the residue in the boat was analyzed and the sulphur lost estimated by difference. In the experiments at low temperature the entire tube was exposed to a temperature of 210°, as determined by thermometer. The HCl was passed over in a strong stream for one hour. The action at this temperature was slight; the results obtained do not, however, show the entire amount of sulphur removed, as some remained in the cool end of the tube, from the dissociation of the hydrogen sulphide. As the action was so slight, no attempt was made to collect and estimate this sulphur remaining in the tube. In the bromine and hydrochloric acid solution was found sulphur as follows:

| | |
|---|---|
| Pyrite at 210° in current of HCl (*a*).................. | 0.94 |
| " " " " (*b*).................. | 0.93 |
| Marcasite at 210° in current of HCl (*a*)............... | 0.77 |
| " " " " (*b*)............... | 0.59 |

More marked results were obtained by increasing the temperature. Similarly conducted experiments were carried out at 310° and 325°, the time of heating ranging from one to three and one-half hours. The temperature of 310° was graded by keeping it between the melting points of $NaHSO_4 \cdot H_2O$ (300°) and $NaNO_3$ (313°), the higher temperature was between the last 313° and the melting point of $KClO_3$ (334°). After the HCl had been passed for a sufficient length of time, the tube was allowed to cool (with the gas current continued until cold) and then the remaining sulphur estimated by oxidizing the contents of the boat with nitric acid and potassium chlorate and precipitating and weighing as $BaSO_4$. The amount found, subtracted from 53.33 %, gave the loss of sulphur. In this case the results obtained by oxidation were reversed, the pyrite lost more sulphur than the marcasite. This is an expression of the fact that the hydrochloric acid gas (or its contained Cl) acts more vigorously on the iron of pyrite than on that of marcasite. The results of the reaction were in each case ferrous chloride in the boat and free sulphur in the tube, the latter from dissociation of the hydrogen sulphide. No ferric chloride was seen in the tube, except a trace with the pyrite. Each mineral was heated for one hour at 310° in a current of the gas and showed loss of sulphur as follows:

| | |
|---|---|
| Pyrite heated at 310° for 1 hour in HCl, sulphur lost...... | 10.73 |
| Marcasite " " " " " ...... | 7.19 |

About the same relative amounts were lost on heating for three and one half hours at 325°. The results thus obtained were as follows:

| | |
|---|---|
| Pyrite heated at 325° for 3½ hours in HCl, sulphur lost.... | 17.13 |
| Marcasite " " " " " .... | 10.70 |

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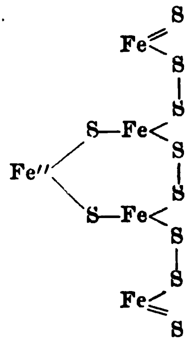
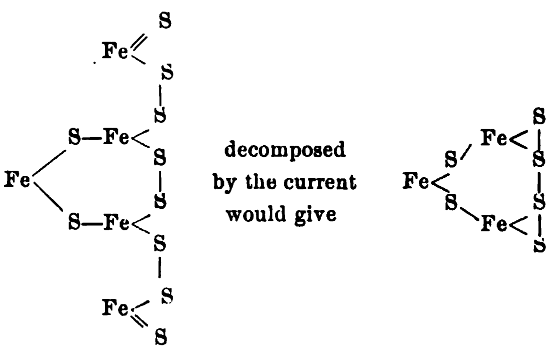
expression of the condition of the iron in the molecule and as embodying in a quantitative way the result of my investigations into its constitution. It will be noticed that the sulphur of the $Fe''S_2$ is made to link entirely with iron.

Structural formula of pyrite.



If ferric iron be considered as $Fe^{iv}—Fe^{iv}$ it is only necessary to connect the ferric Fe atoms with bonds, but it seems to me that ferric iron is more likely $Fe'''$, and at any rate this is the simplest way to regard it. A very striking proof of the correctness of the idea expressed in this structural formula that $Fe''S_2$ in pyrite has its sulphur all linked to iron is afforded in the experiments on oxidation of the mineral by means of the electric current as detailed above. It will be recalled that the amount thus oxidized was between 21 and 22 per cent. Now if two molecules of $FeS_2$ be split off from the above formula, say those linked by sulphur to sulphur there would remain a saturated compound much more difficult to decompose (theoretically) than the pyrite molecule illustrated and the amount of sulphur thus removed would be by calculation 21.33 per cent. This action could be thus illustrated :




Of course this structural formula is only intended to represent the

probable relations of the atoms in the molecule, and the probability that the $Fe''S_2$ is entirely saturated.

A structural formula for marcasite might be given as : $\mathrm{Fe}{<}\begin{matrix} \mathrm{S} \\ | \\ \mathrm{S} \end{matrix}$ and this really expresses our entire knowledge of its constitution. It may be any polymer of this, for being unsaturated it should be capable of forming polymers.

I much regret that want of time has compelled me to discontinue these latter investigations into the decomposibility of these minerals by solutions of metallic salts under pressure, as it seems to open up a way for the study of many other sulphides and would doubtless be productive of most valuable results. Besides this it would probably adduce additional proof of the correctness of my formulas for these minerals as given above.

### Acknowledgment.

I take this occasion to express my sense of gratitude to Prof. Edgar F. Smith, who suggested the work to me, and who by his constant encouragement and ready advice has greatly furthered its prosecution. Many of the experiments were made at his suggestion, and no doubt the success of the work is largely due to him.

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## *Notes on the Osteology of Agriochœrus Leidy (Artionyx O. & W.)*

*By W. B. Scott, College of New Jersey, Princeton.*

*(Read before the American Philosophical Society, May 18, 1894.)*

Leidy described this genus more than forty years ago, and yet in spite of the repeated explorations of the White River and John Day beds, it has hitherto been known only from the skull. In 1893, Osborn and Wortman published, under the name of *Artionyx*, an account of an extraordinary hind foot, which, with a typical artiodactyl tarsus, possesses five digits and very large claw-like ungual phalanges. The authors named refer *Artionyx* to the Ancylopoda on account of the resemblance of its phalanges to those of *Chalicotherium*. An examination of the type specimen of the supposed new genus led me to believe that it represented the hind foot of *Agriochœrus* (see Osborn's *Rise of the Mammalia in North America*, p. 44, separatim). This conclusion was founded upon the fact that the tarsus is not only artiodactyl, but characteristically oreodont in structure, and that certain features of the skull and dentition of *Agriochœrus* indicated that it must be an exceedingly aberrant member of the oreodont group.

Mr. J. B. Hatcher, curator of vertebrate paleontology in the Princeton Museum, has just sent me from the White River bad lands of South Dakota three fragmentary skeletons of *Agriochœrus*, associated with

teeth, the examination of which has yielded some very surprising results. Not only is the conjecture confirmed that *Artionyx* and *Agriochœrus* are synonymous names, but also that the forelimb which I described as ? *Mesonyx dakotensis* (*Proc. Acad. Nat. Sci.*, Phila., 1892, p. 306) probably belongs to some nearly allied form. *Agriochœrus* has thus almost as many synonyms as *Chalicotherium*, and as in that animal its various parts have been referred to no less than three mammalian orders, the head to the artiodactyls, the fore foot to the creodonts and the hind foot to the Ancylopoda.

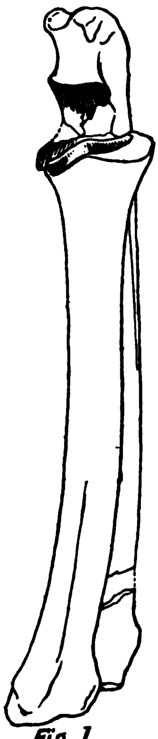

*Fig. 1*

FIG. 1. Left ulna and radius of *A. major* ? ⅔ nat. size. The ulna is too much shortened in the drawing.

These preliminary notes will deal only with some of the more salient features of structure, leaving a complete account of the skeleton for another occasion. Beside the three parts of skeletons already mentioned, the material at present available consists of the fore leg and part of manus, lacking ungual phalanges, of the specimen described as ? *Mesonyx dakotensis* (Museum No. 10492), and a second very similar specimen collected last summer by Mr. Hatcher (No. 10695).

The skull of *Agriochœrus* departs very little from that of the oreodonts, even those features in which it differs from the White River members of that family, such as the open orbit and (probably) the absence of the lachrymal pit, being shared by *Protoreodon* of the Uinta Eocene.

The dentition displays the preëminently characteristic feature of the oreodonts in the conversion of the inferior canine into a functional incisor, while $\overline{\text{p. 1}}$ assumes the form and function of the canine. In other respects the dentition is widely different from that of the oreodonts. Briefly stated, these differences are as follows: (1) The reduction of the upper incisors; (2) the molariform pattern, more or less complete, of p. 4 in both jaws; (3) the structure of the molars, which closely resemble those of *Hyopotamus*, though lacking the protoconule in the upper series. These differences induced Leidy to refer *Agriochœrus* to a family distinct from, but allied to the oreodonts.

The proximal end of the radius is almost exactly like that of *Oreodon*; it is transversely extended, occupying the whole width of the humeral trochlea and antero-posteriorly compressed. The proportions of the three humeral facets are slightly different from those of *Oreodon*, the outer one being relatively narrower and the pit for the intercondylar ridge of the humerus larger and deeper. This applies, however, only to the large species from the upper beds; in *A. antiquus* the correspondence of this por-

tion of the radius with that of *Oreodon* is complete. The shaft has a remarkably strong curvature forward (*i. e.*, with the convexity in front) and is slender with transversely oval section, broadening gradually to the distal end, while in *Oreodon* it continues slender and expands suddenly into the inferior end. The distal portion presents many more points of difference between the two genera than does the proximal and has in *Agriochœrus* quite a deceptively carnivore-like appearance. In the latter it is more thickened transversely and less anteroposteriorly than in *Oreodon*, the scaphoid and lunar facets are less distinctly separated and of different shape and there is no sulcus for the extensor tendons upon the anterior face of the bone. The ulna has an olecranon shaped much like that of *Oreodon* and similarly grooved at the extremity, but decidedly thicker and more massive. The inner humeral facet forms in its distal portion a remarkably prominent flaring lip, far exceeding the corresponding structure in *Oreodon*. The shaft is large throughout; proximally it is trihedral, but soon becomes much compressed laterally and resembles a rib in shape, since the antero-posterior depth is retained. The distal end is contracted to a narrow and simply convex facet for the cuneiform.

The carpus is very different from that of *Oreodon*. A complete account of it cannot yet be given, the only available specimens lacking the scaphoid and pisiform. The lunar is more like that of the Uinta genus *Protoreodon* than that of the White River form. The special peculiarity of the lunar in the true oreodonts lies in its tendency to move over upon the unciform and to make its contact with the magnum altogether lateral. This tendency is already beginning in *Protoreodon* and reaches its culmination in *Merycochœrus* and *Merychyus*. In *Agriochœrus*, on the other hand, this tendency is reversed; the lunar rests almost entirely upon the magnum, its facet for which is broad and but slightly oblique. The anterior portion of this facet is convex, becoming deeply convex behind. The unciform facet is lateral rather than distal in front, but towards the palmar side the unciform extends beneath the lunar. The radial surface is like that of *Oreodon*, but does not descend so low upon the dorsal face of the bone, and the palmar portion does not present so much laterally. The cuneiform is relatively large; proximally it displays a broad concavity for the ulna, while the distal face is occupied by the large subcircular facet for the unciform. The pisiform facet is flat and notably small, whereas in *Oreodon* it is concave and occupies the whole palmar side of the bone. The trapezium is somewhat of a surprise in its shape and connections; it

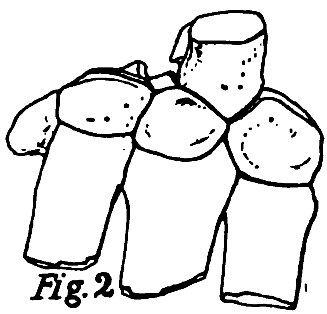


FIG. 2. Part of left manus of *A. major?* Nat. size. The trapezium is incorrectly placed, the surface in contact with the trapezoid being that for the scaphoid.

is a small nodular bone, which is attached to the scaphoid and trapezoid, but has no facet for a first metacarpal. In view of the fact, indicated by Osborn and Wortman, and confirmed by one of the specimens received from Mr. Hatcher, that a hallux was present in the pes, the absence of the pollex, which is preserved in at least two oreodonts, is decidedly unexpected. There is reason to believe, however, that the pollex was retained in *A. antiquus*. The trapezoid is considerably larger than the magnum, especially its dorsal portion; posteriorly it is excavated on the ulnar side for the extension of the magnum. The surface for the scaphoid is somewhat warped; broad and proximal in front, narrower and obliquely lateral behind. The distal portion of the trapezoid articulates only with the second metacarpal. The magnum differs from that of *Oreodon* in several important respects. Its proximal surface is occupied principally by the lunar, the scaphoid being confined to a relatively narrow surface in front, though posteriorly the contact is more considerable, and further the magnum has but a very small facet for the second metacarpal. The unciform differs considerably from that of *Oreodon*. Anteriorly the lunar facet forms an excavation upon the radial side of the bone, but posteriorly an almost cylindrical process extends beneath the lunar. The proximal surface, which in *Oreodon* is divided equally between the lunar and cuneiform facets, is occupied almost entirely by the facet for the cuneiform. The articular surface for the fifth metacarpal differs from that of the last-named genus in its larger relative size and more distal position, and the posterior hook of the unciform is decidedly more massive.

The metacarpals are represented by the proximal and distal ends of the second and fourth and by the third complete. They display several significant differences from those of *Oreodon*. As already mentioned, the pollex was probably entirely absent and the other metacarpals are of more uniform size, giving a more isodactyl form of manus than in *Oreodon*. The head of mc. II is slightly smaller than that of mc. IV, and has a large concave facet for the trapezoid and a very minute one for the magnum. The shaft is more rounded and less antero posteriorly compressed than in *Oreodon*. The distal end is creodont rather than ungulate in appearance. This appearance is due to the great enlargement of the processes for attachment of the lateral ligaments, the more distinct constriction of the trochlea and its almost spherical shape and to the greater prominence of the carina. Mc. III is the heaviest of the series; it bears a large facet for the magnum, which is convex antero-posteriorly and concave transversely, and abuts against the unciform by a process which overlaps the head of mc. IV; this process is, however, relatively smaller than in *Oreodon*. Mc. IV requires no particular description; it is rather smaller than mc. III and somewhat larger than mc. II.

The phalanges are, at first sight, very different from those of *Oreodon*, but a careful comparison shows important resemblances, especially if the small species, *A. antiquus*, from the lower beds be considered. In the proximal phalanx the following differences from *Oreodon* may be observed: (1)

The proximal articular surface is more deeply concave, and more oblique to the long axis of the bone, presenting dorsally as well as proximally. (2) The distal trochlea is less depressed, more deeply notched and extends farther upon the palmar side. In the second phalanx the dorso-palmar diameter is relatively much greater and the transverse diameter less than in *Oreodon*. The median ridge of the proximal trochlea is much more prominent and the lateral concavities of this surface more deeply excavated. The distal articular facet is much more extensive, especially upon the palmar side, and more deeply notched in the middle line. The ungual is compressed and forms a large claw, quite unlike the slender pointed hoof of *Oreodon*, though the difference is hardly a fundamental one. The facet for the second phalanx is much greater in the dorso-palmar direction and allows a more extended movement of the two bones upon each other. The mutual relations of the three phalanges is quite different in the two genera; in *Agriochœrus* the arrangement is much like what is found in *Chalicotherium*.

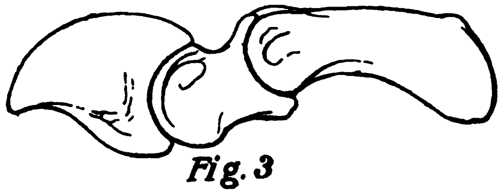

Fig. 3

FIG. 3. Phalanges of IV digit of manus. Same individual as Figs. 1 and 2, nat. size.

The tibia differs in several important respects from that of *Oreodon*. The proximal end is carnivorous rather than ungulate in appearance. This is due partly to the flatness of the condyles and their slighter obliquity from before backward, but especially to the small prominence of the cnemial crest, which though broad and massive is much lower than in *Oreodon*, and hence the proximal portion of the tibia has a decidedly smaller antero-posterior diameter than in that genus; the spine is also less conspicuous. The distal end is remarkable for the great size of the internal malleolus, which is very long and has an articular facet for the astragalus upon its free end.

The tarsus has already been fully described by Osborn and Wortman. It is requisite here, therefore, only to call attention to the differences which obtain between the various species of *Agriochœrus*, as well as between the latter genus and *Oreodon*. In the absence of teeth it cannot yet be determined whether the specimen described by Osborn and Wortman should be referred to any of Leidy's species and therefore, for the purposes of the present comparison, the name *A. gaudryi* O. and W. will be retained. *A. antiquus* from the Oreodon beds differs from *A. gaudryi* in the following particulars: (1) The size is somewhat smaller. (2) All the elements of the tarsus are relatively higher and narrower. (3) There is less difference in size between the internal and external condyles of the astragalus and the latter is separated by a much wider interval from the cuboidal facet. (4) The pit for the internal malleolus is much less deeply

incised. (5) The fibular facet of the calcaneum is higher and more oblique, but less extended antero-posteriorly. (6) The calcaneal facet of the cuboid is relatively broader, while that for the astragalus is narrower. Unfortunately the compound cuneiform is lost from the specimens of *A. antiquus* and the only navicular preserved is too much injured for comparison.

The tarsus of *Agriochærus* is fundamentally similar to that of *Oreodon*, but with many significant differences of detail. Comparing *O. culbertsoni* with *A. antiquus* the following deviations in the structure of the latter may be observed. (1) All the tarsal bones are much lower and broader. (2) The pit on the astragalus for the tibial malleolus is much deeper and the ridge separating the cuboid and navicular facet of this bone is decidedly more prominent. (3) The sustentaculum of the calcaneum is much more strongly developed and projecting. (4) The calcaneal facet descends lower upon the dorsal face of the cuboid; the hook-like process on the plantar surface of the cuboid is very much more massive and the distal facet for the fifth metatarsal less distinctly separated from that for the fourth. In *A. gaudryi* the plantar hook of the navicular is greatly increased in breadth as compared with that of *O. culbertsoni*, and on the distal surface of the compound cuneiform the facets for the second and third metatarsals lie in the same transverse plane, instead of being at different levels. In consequence of this arrangement the second metatarsal, which in *Oreodon* abuts against the tibial side of the ectocuneiform, is entirely excluded from that element. Whether the same is true of *A. antiquus* cannot at present be determined. In one of the specimens of the latter species the entocuneiform is preserved. It is considerably wider than the same bone in *Oreodon*, and has a distal facet for the first metatarsal, thus confirming Osborn and Wortman's observation as to the presence of a hallux in this genus. A number of caudal vertebræ show that *Agriochærus* had a longer and more powerful tail than *Oreodon*; indeed, the tail is quite as well developed as in the larger cats, *e. g.*, the leopard. I have elsewhere called attention to the curious character of the axis in this genus (*Morphologisches Jahrbuch*, Bd. xvi, p. 361). The odontoid process has the characteristic shape found in the oreodonts; it is short and broad, with strongly convex ventral surface, nearly flat dorsal surface, and rounded anterior margin. This process is, therefore, neither conical nor spout-shaped, but intermediate between the two. The neural spine, on the other hand, is entirely different from that of the oreodonts and forms a great hatchet-shaped plate, resembling carnivorous rather than ungulate structure.

### The Systematic Position of Agriochœrus.

Leidy separated this genus from the oreodonts, as the type of a distinct family, which he regards as a "peculiar and extinct family of ruminants of the most aberrant character, but allied to the *Oreodonts*." Gill united the two families, giving to *Agriochærus* subfamily rank, an example which

was followed by Cope and by myself. Osborn and Wortman referred their genus *Artionyx* to the Ancylopoda with *Chalicotherium*, constructing a new suborder, the Artionychia, for its reception. While much remains to be learned regarding *Agriochœrus*, some inferences from the facts of structure described in the preceding pages are reasonably clear. In the first place, I cannot agree with Osborn and Wortman in removing this genus altogether from the Artiodactyla and assigning it to the Ancylopoda. Such a removal implies that all of the artiodactyl features of structure have been independently acquired, and this is highly improbable. I have, it is true, repeatedly insisted upon the reality and frequency of parallelism in development, but it is very easy to push this doctrine to unwarranted extremes. Among mammals, at least, no such extreme case of this mode of evolution is known as would include the skull, dentition, limbs, carpus and tarsus, and in fact everything but the phalanges. The only evidence which could justify such a conclusion would be the finding of a succession of species by which the independent origin of the two groups could be traced out step by step. The agreement of *Agriochœrus* with *Chalicotherium* is of the slightest and most superficial character, consisting only in the fact that both genera have claws. But the ungual phalanges are of a very different pattern in the two genera, and it is surely the less dangerous horn of the dilemma to conclude that this single correspondence is due to parallelism rather than that the numerous and important characters in which *Agriochœrus* agrees with the artiodactyls are the result of such a process.

But a difficulty arises here; is not the distinction between hoof and claw a fundamental one, established long before the artiodactyls had arisen? To answer this question with any certainty would require a much more exact knowledge of the genesis of both kinds of phalanx than we at present possess, but there is much reason to believe that while the ungulate and unguiculate types of mammals are radically distinct, yet the distinction does not rest, as the names imply, upon the character of the unguals. At all events both hoof and claw are found in closely allied genera, as for example, among the rodents, creodonts and edentates. These examples are, it is true, all found among the unguiculates, but there is no *a priori* reason for assuming that a similar diversity among the ungulates may not occur. That it is rare in the latter group is doubtless due to the fact that ungulates almost uniformly employ the feet only for purposes of locomotion, and indeed it is difficult to conjecture what the function of such feet as those of *Agriochœrus* and *Chalicotherium* may have been. In view of all the characteristic artiodactyl structures which *Agriochœrus* displays, one can hardly escape the conclusion that in this case the transition from hoof to claw has actually taken place and that this genus is the culmination of a series of aberrant artiodactyls. In the second place it is obvious that Leidy's separation of *Agriochœrus* from the *Oreodontidæ* is entirely proper. A more obscure problem is to determine the relationship between the two families, and to this end it will be necessary to briefly

recapitulate their resemblances and differences. *Agriochœrus* resembles the oreodonts in the following points: (1) The skull structure of the two families is closely alike and the Uinta genus *Protoreodon* hardly differs at all in this respect from *Agriochœrus*. (2) The very characteristic oreodont features of the caniniform first lower premolar and incisiform canine are repeated in *Agriochœrus*. (3) The atlas and the peculiar odontoid process of the axis are similar in both groups. (4) The elbow joint in the oreodonts is, as is well known, very exceptional among ungulates and all its peculiarities are repeated in somewhat exaggerated form in *Agriochœrus*. (5) The tarsus is oreodont in almost every particular, and is curiously paralleled in many details by that of the Loup Fork genus *Merycochœrus*. It should be remembered in this connection that in *A. antiquus* the tarsus deviates less from the oreodont type than does that of the later and larger *A. gaudryi*, and is in fact intermediate between the two. This is significent, because in the long continued existence of the *Oreodontidæ* from the Uinta to the Loup Fork, there is relatively little change in the tarsus, while each successive genus displays its own particular modification of the carpus. (6) The phalanges, except the unguals, differ relatively little in the two groups and are manifestly of the same type. (7) The articulations of the metapodials are similar.

The most important respects in which *Agriochœrus* differs from the oreodonts are as follows: (1) The pattern of the molar teeth is very distinct, but this gap, especially as regards the lower teeth, is to some extent bridged by *Protoreodon* of the Uinta Eocene, which shows that the two kinds of molar may well have been derived from a single type. (2) The distal end of the radius is creodont, rather than ungulate in character. (3) In *Agriochœrus* the carpus differs decidedly from that of the White River oreodonts, both in the shape and in the connections of its parts, the displacement being in opposite directions. Here again *Protoreödon* tends to connect the two extremes and displays a type of carpus not far removed from that which may have given rise to both. (4) The position of the phalanges with reference to the metapodials and to each other is quite different. (5) Much the most remarkable difference between the two groups is the presence of claws in *Agriochœrus*, while the oredonts have hoofs. (6) Though the large *Agriochœrus* species from the uppermost White River beds has no pollex, there is reason to believe that it was present in the earlier and smaller *A. antiquus*. (7) A striking difference in the knee-joint is observable between *Agriochœrus* and the oreodonts, which indicates that in the former the leg was straighter, while the proximal end of the tibia and distal end of the femur have quite the appearance of the same parts in the Carnivora. (8) All the elements of the tarsus are lower and broader, the astragalus has a deep pit for the internal malleolus and a hallux is present. The latter has not been found in any oreodont. (9) Another carnivorous feature in *Agriochœrus* is the shape assumed by the neural spine of the axis.

In brief, the dentition and skeleton of *Agriochœrus* show a large num-

ber of close correspondences with the oreodonts and especially in those particulars in which that group differs from other artiodactyl families. On the other hand, there are significant deviations from the oreodonts, which are to be found more particularly in the structures correlated with the curious change in foot structure. It seems on the whole highly probable that the two families are not distantly related, especially if the somewhat intermediate character of *Protoreodon* be considered.

The conclusion to which the available evidence leads is, then, that *Agriochœrus* is the last term in a succession of species which form a curiously specialized offshoot of the *Oreodontidæ*, its divergences from that family being principally the results of a change in the functions and uses of the feet. The separation of the two series was probably already established in the Uinta Eocene, for, in spite of its somewhat intermediate character, *Protoreodon* can be a forerunner only of the oreodonts. The Bridger beds may be expected to yield the common ancestor of the two series, and this animal will probably turn out to be a pentadactyl form, with buno-selenodont dentition and quinquetuberculate upper molars, the unpaired lobe in the anterior half of the crown. As I have elsewhere suggested, this hypothetical form may have been already found in the imperfectly known *Helohyus*.

The likeness of the *Agriochœrus* molars to those of *Hyopotamus* has often been noticed and the inference drawn that these two genera were in some manner more or less closely related. Mr. Hatcher writes me that he has lately found feet of *Hyopotamus* which suggest the same affinities. Until this material has been carefully studied, it will be the part of prudence not to prejudge the question.

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## *Three New Methods for the Detection of Forgery.*

*By Dr. Persifor Frazer.*

*(Read before the American Philosophical Society, May 18, 1894.)*

I wish to put on record three new methods which I have applied successfully for the purpose of detecting frauds in written documents.

The first enables one to determine with comparative ease which of two crossing ink lines was made first, and consists in observing the crossing by a lens of low power (four or five diameters) at a very oblique angle. If a light ink line be made over a darker one the appearance to the eye when viewing the crossing perpendicularly to the plane of the paper will be that the darker line is superposed. The reason of this is that ink lines are quite transparent and the darker line is seen through the lighter one and seems to make one continuous line with its two limbs

across the intersection. When the paper is inclined, however, but few of the rays of light which reach the eye by reflexion from the intersection traverse and lose rays by absorption from both ink films; but the greater number penetrate only the upper ink and do not suffer absorption by the lower.

The second is a method of judging whether or not two lines have been made with the same ink and consists in passing over each in succession prisms of red, yellow or blue glass (or two of these), and noting the number of millimeters through which it is necessary to move each prism from the position where its thin edge is in contact with the mark to be judged to that where the color is extinguished and the line is black. The prism is pushed horizontally over the ink mark continually adding to the thickness of the colored glass over the latter. When the line appears quite black the distance in mm. over which the prism has been pushed is read off and compared with the number of mm. which the other line requires to attain the same result. If the inks have the same colors these results must agree.

Third method. In 1886 I read before the Society a paper on the use of composite photography for the purpose of establishing the type of an individual's writing and especially the signature. Since then the mechanical difficulties in the way have been greatly lessened and the method has given most valuable results in cases before various courts. But there are many occasions where it cannot be employed for one reason or another, and in such cases I have devised a system of measurement and tabulation which accomplishes by figures what composite photography established automatically by form. The older method may be called the graphic average of the handwriting and the later the numerical average. The advantage of the former is that it takes into account at once *all* the elements of character, while the latter can deal only with comparatively few, but in spite of this the results attained have been very interesting.

By the system here alluded to a given number of heights, breadths and angles of letters, and spaces between them and between words, are selected and measured in a large number of undisputed signatures. The same elements are then measured in the signature in dispute. The averages of all the elements in the genuine series is then compared with the latter, and their agreement or disagreement will generally lead to a correct judgment as to the genuineness of the disputed signature.

This method has given successful results in a direction which extends the original idea to a study of "guided hands," and it has been possible to extract from the columns of measurements, proofs of the existence of characteristics of each of the separate handwritings.

*Stated Meeting, May 4, 1894.*

Mr. INGHAM in the Chair.

Minutes of preceding meeting read.

Letters of envoy were received from the Survey of India Department, Calcutta; K. Sächsische Gesellschaft der Wissenschaften, Leipzig, Saxony; Faculté des Sciences, Marseilles, France; Mrs. Carvill Lewis, London, Eng.

Letters of acknowledgment were received from the Royal Society of New South Wales, Sydney (142); Imperial Academy of Sciences, Physical Central Observatory, Russian Chemical Society, Library of the Ministry of Marine, Prof. Serge Nikitin, St. Petersburg, Russia (142); K. Vetenskaps Akademiens Bibleotek, Statistika Central Byrån, Stockholm, Sweden (142); Maatschappij van Nederlandsche Letterkunde, Leiden, Z. Holland (142); Bibliotheque R. de Belgique, Bruxelles (140, 141); Redaction der *Naturwissenschaftlichen Wochenschrift*, Berlin, Prussia (141); R. Accademia dei Lincei, Rome, Italy (142); Bibliothèque Universitaire, Lyon, France (130–135); Mercantile Library, Philadelphia (135); Mr. Everard F. im Thurn, Georgetown, British Guiana (141).

Letters of acknowledgment (144) were received from the Engineers' Club, Franklin Institute, University of Pennsylvania, Mercantile Library, Pennsylvania Historical Society, Free Library of Philadelphia, Academy of Natural Sciences, Wagner Free Institute, Numismatic and Antiquarian Society, Gen. I. J. Wistar, Admiral Macauley, Profs. E. D. Cope, H. D. Gregory, Lewis M. Haupt, H. V. Hilprecht, J. P. Lesley, James MacAlister, Drs. John Ashhurst, Jr., J. Solis Cohen, Persifor Frazer, W. W. Keen, Morris Longstreth, John Marshall, Charles A. Oliver, C. N. Peirce, W. S. W. Ruschenberger, H. Clay Trumbull, W. H. Wahl, Messrs. R. L. Ashhurst, R. Meade Bache, Patterson DuBois, Jacob B. Eckfeldt, Robert P. Field, E. V. d'Invillier, W. W. Jefferis, Franklin Platt, Theodore D. Rand, Louis Vossion, J. M. Wilson, Ellis Yarnall, Philadelphia; Mr. Heber S. Thompson, Pottsville, Pa.; Rev. F.

A. Muhlenberg, Reading, Pa.; Rev. G. W. Anderson, Rosemont, Pa.; Dr. W. H. Appleton, Swarthmore, Pa.; Dr. John Curwen, Warren, Pa.; Mr. Philip P. Sharples, West Chester, Pa.; Wyoming Historical and Geological Society, Wilkes-barre, Pa.; Maryland Institute for the Promotion of the Mechanic Arts, Enoch Pratt Free Library, Baltimore, Md.; Journal of the U. S. Artillery, Fortress Monroe, Va.; Mr. Jedediah Hotchkiss, Staunton, Va.; Leander McCormick Observatory, Library of the University of Virginia, Prof. J. W. Mallet, University of Virginia; Agricultural Experiment Station, Experiment, Ga.; Georgia Historical Society, Savannah; Michigan State Library, Lansing; Athenæum, Columbus, Tenn.; Dr. Robert Peter, Lexington, Ky.; Prof. E. W. Claypole, Akron, O.; University of Cincinnati, Society of Natural History, Cincinnati Observatory, Cincinnati, O.; Oberlin College, Oberlin, O.; Purdue Experiment Station, La Fayette, Ind.; Prof. G. W. Hough, Evanston, Ill.; State Historical Society of Wisconsin, Wisconsin Academy of Science, Arts and Letters, Madison.

Accessions to the Library were reported from Prof. N. A. Cobb, Sydney, Australia; Great Trigonometrical Survey of India, Dehra Dun; Etat Independant du Congo, Brussels, Belgium; Musée Naturelle de Hongrie, Budapest; K. Akademie der Wissenschaften, Vienna, Austria; Gesellschaft für Anthropologie, Ethnologie und Urgeschichte, Berlin, Prussia; Naturwissenschaftliche Verein, Bremen, Germany; Schlesische Botanische Tausch-Verein, Breslau, Prussia; Prof. August Tischner, Leipzig, Saxony; Geographische Gesellschaft, Bern, Switzerland; Société Vaudoise des Sciences Naturelles, Lausanne, Switzerland; Société Francaise de Physique, Paris, France; Mrs. Carvill Lewis, London, Eng.; Geological Society, Glasgow, Scotland; Canadian Institute, Toronto, Canada; American Statistical Association, Prof. Alexander Macfarlane, Boston, Mass.; Prof. C. L. Doolittle, Salem, Mass.; Agricultural Experiment Station, Newark, N. J.; Academy of Natural Sciences, Mercantile Library, Mr. Frederick Prime, Philadelphia; Office of the Chief of Engineers, U. S. Department

of Agriculture, Anthropological Society, U. S. Fish Commission, Census Office, Washington, D. C.; Lick Observatory, Mt. Hamilton, Cal.; Iowa Masonic Library, Cedar Rapids; Geological Survey, Des Moines, Ia.; Deutsche Wissenschaftliche Verein, Santiago de Chile; Sociedad de Ingenieros, Puebla, Mex.

Mr. Henry Carey Baird, in the following letter, presented to the Society, on behalf of the contributors, a handsome portrait of George Ord, a former Vice-President of the Society:

To the President of the American Philosophical Society:

*Mr. President*:—The pleasant duty has devolved on me, on behalf of a number of members of the Society, subscribers, of presenting to the Society a portrait of the late George Ord.

This portrait has been copied by Mr. T. Henry Smith from the original by John Nagle, painted in 1829, the property of the Academy of Natural Sciences, to the courtesy of the officers of which institution we are indebted for permission to make this copy.

Mr. Ord was an eminent Philadelphian, having been born here in 1781, and died here January 24, 1866. He was elected a member of this Society October 17, 1817, was Secretary 1820–1827 and also in 1829, Vice-President 1832–1835, Librarian 1842–1848, Treasurer 1842–1847, Councilor 1836. From 1851 to 1858 he was President of the Academy of Natural Sciences. He was also a fellow of the Linnean Society of London.

He was an intimate friend of the naturalist Alexander Wilson, and was his companion in many of his ornithological expeditions. After Wilson's death, in 1813, Mr. Ord completed the eighth volume of Wilson's *Ornithology* (Philadelphia, 1814). In 1825 he prepared a new edition of the last three volumes, and in 1828 published his *Life of Wilson*. In 1834 he wrote the *Memoirs of Thomas Say*, and in 1849 a *Memoir of Charles A. Lesueur*. While his special department was that of natural history and especially ornithology, his labors as a lexicographer were important, having aided in editing Johnson's Dictionary, and having contributed valuable matter to the dictionary of Noah Webster.

It seems eminently fitting that a portrait of this distinguished member of the Society should adorn the walls of its hall, and it is hoped that this faithful reproduction of Nagle's admirable picture may be thought worthy of the subject.

Philadelphia, May 4, 1894. Henry Carey Baird.

The letter was ordered spread on the minutes with the list of donors.

Dr. Morris moved a vote of thanks to the donors, which was adopted.

Committees on "Membership" and the "Memorial Dinner" reported progress.

A letter was received from Mr. Ben. D. Peter, Lexington, Ky., announcing the death of his father, Dr. Robert Peter, April 26, 1894, æt. 89.

Obituary notice of George de Benneville Keim was read by Dr. Brinton.

Mr. Bache read his views on "The Dynamics of Boxing."

Nomination No. 1273 was read.

Mr. Prime moved and Dr. Brinton seconded the following resolution:

*Resolved*, That J. Sergeant Price, the Treasurer of the American Philosophical Society, is hereby authorized and directed to cast the vote to which the corporation is entitled as a policy holder and contributor of "The Philadelphia Contributionship for the Insurance of Houses from Loss by Fire," at any election for Directors and Treasurer of the corporation last named, to serve for the year ending the second Monday of April, 1895, and to vote on any questions that may arise at the meeting at which the said election is held.

The resolution was unanimously adopted.

And the Society was adjourned by the presiding member.

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*Stated Meeting, May 18, 1894.*

President FRALEY in the Chair.

Col. Henry DuPont, a newly elected member, was presented to the Chair, and took his seat.

Minutes of meeting May 4th read.

Correspondence was submitted as follows:

Letters of envoy were received from the Institut Egyptien, Cairo; Geological Survey of India, Calcutta; K. K. Astronomisch-meteorologische Observatorium, Triest, Austria; Université de Lyon, Lyon, France; Royal Statistical Society,

London, Eng.; Direction Générale de Statistique, La Plata, S. A.

Letters of acknowledgment were received from the Royal Mint, Melbourne, Australia (139, 140); Académie Hongroise des Sciences, Budapest (135, 136, 137); Schweizerische Naturforschende Gesellschaft, Bern, Switzerland (142); Prof. Giovanni Capellini, Bologna, Italy (142); R. Academia di Scienze, Lettere ed Arti, Padua, Italy (142); Université de Lyon, Lyon, France (130–139, 141).

Letters of acknowledgment (144) were received from the Geological Survey Department, Dr. Alfred R. C. Selwyn, Ottawa, Canada; Literary and Historical Society, Laval University, Hon. J. M. LeMoine, Quebec, Canada; Canadian Institute, Toronto; Society of Natural History, Portland, Me.; Dartmouth College, Prof. Charles H. Hitchcock, Hanover, N. H.; Vermont Historical Society, Montpelier; Rhode Island Historical Society, Providence; Franklin Society, Providence, R. I.; Boston Society of Natural History, Massachusetts Historical Society, Public Library, Mr. Robert C. Winthrop, Boston, Mass.; Museum of Comparative Zöology, Mr. Robert N. Toppan, Prof. J. D. Whitney, Dr. Justin Winsor, Cambridge, Mass.; Free Public Library, New Bedford, Mass.; Essex Institute, Salem, Mass.; American Antiquarian Society, Worcester, Mass.; Mr. George F. Dunning, Farmington, Conn.; Connecticut Historical Society, Hartford; Yale University, Profs. O. C. Marsh, W. D. Whitney, New Haven, Conn.; Agricultural Experiment Station, Storrs, Conn.; State Library, Prof. James Hall, Albany, N. Y.; Buffalo Library, Buffalo, N. Y.; Prof. Edward North, Clinton, N. Y.; Prof. J. M. Hart, Ithaca, N. Y.; Columbia College, N. Y. Academy of Medicine, N. Y. Historical Society, American Museum of Natural History, N. Y. Hospital Library, Prof. Joel A. Allen, Hon. Charles P. Daly, Dr. Daniel Draper, New York, N. Y.; Vassar Brothers' Institute, Poughkeepsie, N. Y.; Geological Society of America, Rochester, N. Y.; Prof. W. Le Conte Stevens, Troy, N. Y.; Oneida Historical Society, Utica, N. Y.; Free Public Library, Jersey City, N. J.; Prof. Robert W.

Rogers, Madison, N. J.; New Jersey Historical Society, Newark, N. J.; Profs. W. Henry Green, Charles W. Shields, C. A. Young, Princeton, N. J.; Dr. Charles B. Dudley, Altoona, Pa.; Dr. Robert H. Alison, Ardmore, Pa.; Prof. M. H. Boyè, Coopersburg, Pa.; Hon. Eckley B. Coxe, Drifton, Pa.; Dr. Traill Green, Prof. J. W. Moore, Rev. Thomas C. Porter, Easton, Pa; Mr. Andrew S. McCreath, Harrisburg, Pa.; Haverford College, Prof. Lyman B. Hall, Haverford, Pa.; Mr. John Fulton, Johnstown, Pa.; Linnean Society, Lancaster, Pa.; Prof. F. A. Genth, Jr., Lansdowne, Pa.; Mr. P. F. Rothermel, Linfield, Pa.; Hon. James T. Mitchell, Prof. Albert A. Smyth, Philadelphia; Philosophical Society, West Chester, Pa.; Col. H. A. DuPont, Wilmington, Del.; U. S. Geological Survey, Surgeon-General's Office, U. S. Coast and Geodetic Survey, Smithsonian Institution, Catholic University, U. S. Weather Bureau, Drs. J. S. Billings, W. J. Hoffman, Col. Garrick Mallery, Prof. Charles A. Schott, Mr. William B. Taylor, Washington, D. C.; University of Tennessee, Knoxville; Texas Academy of Science, Austin; University of California, Prof. Joseph Le Conte, Berkeley, Cal.; Lick Observatory, Mt. Hamilton, Cal.; Prof. George Davidson, San Francisco, Cal.; Academy of Natural Sciences, Davenport, Ia.; State Historical Society, Iowa City, Ia.; Kansas University Quarterly, Lawrence; Nebraska State Historical Society, Agricultural Experiment Station, Lincoln, Neb.; State Agricultural College, Fort Collins, Colo.; Academy of Science, Tacoma, Wash.; University of Wyoming, Laramie; College of Agriculture, Las Cruces, New Mexico.

Letters of acknowledgment for Certificate of Membership were received from Dr. Samuel A. Green, Boston, Mass.; Prof. J. M. Hoppin, New Haven, Conn.; Gen. Isaac J. Wistar, Philadelphia.

Accessions to the Library were reported from the Geological Survey of India, Calcutta; R. Accademia degli Agiati, Roveredo, Tyrol; Osservatorio Astronomico Meteorologico, Triest, Illyria; Université de Lyon, France; Société de Géographie, Toulouse, France; Royal Institution, London, Eng.;

American Oriental Society, New Haven, Conn.; Historical Society, Buffalo, N. Y.; Oneida Historical Society, Utica, N. Y.; Zoölogical Society, Editor of the *Naturalist's Leisure Hour*, Indian Rights' Association, Editors of the *International Journal of Ethics*, Prof. E. D. Cope, Dr. Charles A. Oliver, Philadelphia; University of Michigan, Ann Arbor; Observatorio Meteorologico Central de Xalapa, Mexico; Bureau d'Exchanges Internationaux de Publications de la Republique Oriental de l'Uruguay, Montevideo; Agricultural Experiment Stations, Fayetteville, Ark.; La Fayette, Ind.; Brookings, S. Dak.; Tucson, Ariz.

A photograph was received from the Yorkshire Geological and Polytechnic Society, Halifax, Eng., of Mr. James W. Davis, Honorary Secretary.

Council met, and adjourned without business.

The President appointed Dr. Ruschenberger, who accepted, to prepare an obituary of Dr. W. V. Keating.

Mr. Price moved, and Dr. Ruschenberger seconded the motion, to postpone the election of members until next regular time for election, on account of small attendance owing to very stormy weather.

Mr. Lyman read his paper on "Some New Red Horizons."

Dr. Frazer followed with remarks on his own work in the same horizons as illustrated in Adams, York, Lancaster and Cumberland counties in the State.

Prof. Cope read by title a paper from Prof. Scott entitled "Notes on the Osteology of *Agriochœrus* Leidy;" also a paper entitled "On the Lungs of the Ophidia," by himself.

Prof. Barker read a communication entitled, "Comparative Study of the Chemical Behavior of Pyrite and Marcasite," by Amos Peaslee Brown.

Dr. Frazer indicated his method of detecting forgeries in documents and handwriting.

And the meeting was adjourned by the President.

PROCEEDINGS

OF THE

# AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA FOR PROMOTING USEFUL KNOWLEDGE.

VOL. XXXIII. JULY TO DECEMBER, 1894. NO. 146.

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☞ It is requested that the receipt of this number be acknowledged.

☞ In order to secure prompt attention it is requested that all correspondence be addressed simply "To the Secretaries of the American Philosophical Society, 104 S. Fifth St., Philadelphia."

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# EXTRACT FROM THE LAWS.

## CHAPTER XII.

### OF THE MAGELLANIC FUND.

SECTION 1. John Hyacinth de Magellan, in London, having in the year 1786 offered to the Society, as a donation, the sum of two hundred guineas, to be by them vested in a secure and permanent fund, to the end that the interest arising therefrom should be annually disposed of in premiums, to be adjudged by them to the author of the best discovery, or most useful invention, relating to Navigation, Astronomy, or Natural Philosophy (mere natural history only excepted); and the Society having accepted of the above donation, they hereby publish the conditions, prescribed by the donor and agreed to by the Society, upon which the said annual premiums will be awarded.

### CONDITIONS OF THE MAGELLANIC PREMIUM.

1. The candidate shall send his discovery, invention or improvement, addressed to the President, or one of the Vice-Presidents of the Society, free of postage or other charges; and shall distinguish his performance by some motto, device, or other signature, at his pleasure. Together with his discovery, invention, or improvement, he shall also send a sealed letter containing the same motto, device, or signature, and subscribed with the real name and place of residence of the author.

2. Persons of any nation, sect or denomination whatever, shall be admitted as candidates for this premium.

3. No discovery, invention or improvement shall be entitled to this premium, which hath been already published, or for which the author hath been publicly rewarded elsewhere.

4. The candidate shall communicate his discovery, invention or improvement, either in the English, French, German, or Latin language.

5. All such communications shall be publicly read or exhibited to the Society at some stated meeting, not less than one month previous to the day of adjudication and shall at all times be open to the inspection of such members as shall desire it. But no member shall carry home with

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*Stated Meeting, September 7, 1894.*

President, Mr. FRALEY, in the Chair.

The death of Lord Coleridge, Chief Justice of England, was announced.

Mr. Lyman read the following correction of a statement made by Dr. Frazer in the last number of the Proceedings:

"In the last issue of the Proceedings, Vol. xxxiii, p. 216, for our last meeting, May 18, 1894, Dr. Persifor Frazer makes public a wholly mistaken impression in regard to my position and influence in the State Geological Survey. So far from being its 'quasi director,' I have never even had the honor of being strictly speaking a regularly employed, salaried Assistant Geologist of the Survey, but have only done contract-work for it; and have never had anything whatever to do directly or indirectly, by authority or by advice, in responsibility or in consultation, with the management or control of any part of the work of the Survey, except my own.

"In writing out his remarks, he must have believed he had uttered them essentially as they are printed; but anything in the least like so inexact a statement in that matter would have been corrected at once.

"BENJ. SMITH LYMAN."

Mr. Prime spoke of the gold regions of South Africa.

Pending nominations 1273, 1274, 1276 to 1301 (inclusive) were read.

And the Society was adjourned by the President.

*Stated Meeting, September 21, 1894.*

President, Mr. FRALEY, in the Chair.

Correspondence was submitted as follows:

Letters acknowledging the receipt of diploma from Dr. Isaac Roberts, Crowborough, Sussex, England, and Hon. Robert E. Pattison, Harrisburg, Pennsylvania.

A circular from the Royal Society of New South Wales, Sydney, in reference to prizes for 1894, 1895 and 1896.

A circular from the Palæographical Society of Australasia, Sydney, setting forth the objects of the Society.

Communication from the Council of the Imperial Russian Geographical Society, in reference to the necessity of an International Agreement with regard to the publication of material contained in Naval Meteorological Journals.

Circular from the Secrétariat Général de la Société de Géographie de Toulouse, in reference to a decimal division of the day.

Prospectus of the nature and objects of the Royal Institution of Great Britain, London, England.

A letter from N. Borovko, Odessa, Russia, in reference to the question of an international language.

Letters of envoy were received from the Royal Society of New South Wales, Sydney; Mr. Edward Cousel, Melbourne, Australia; Geological Survey of India, Calcutta; Government Astronomer, Madras, India; Société Imp. Mineralogique, Comité Geologique, Observatoire Physique Central, St. Petersburg, Russia; Academia Romania, Bukarest; Universite R. de Norvège, Christiania; Fondation de P. Teyler van der Hulst, Hárlem, N. Holland; Maatschappif der Nederlandsche Letterkunde, Leiden, Z. Holland; K. Leopoldinisch-Carolinische Deutsche Akademie der Naturforscher, Halle a. S., Prussia; Gesellschaft zur Beförderung der gesammten Naturwissenschaften, Marburg, Prussia; Würtembergische Verein für Handelsgeographie, Stuttgart; Musée Guimet, Bureau of Longitudes, Société Philologique, Paris, France; Zoölogical

Society, Royal Society, London, Eng.; Royal Dublin Society, Royal Irish Academy, Dublin, Ireland; Geological Society of America, Rochester, N. Y.; U. S. Naval Institute, Annapolis, Md.; Musée de La Plata, La Plata, Argentine Republic, S. A.; Société Scientifica du Chili, Santiago; Instituto Fisico Geografico Nacional, San José, Central America.

Letters of acknowledgment were received from the Tokyo Library, Tokyo, Japan (139, 140, 141); Linnean Society of N. S. Wales, Sydney (141); R. Geographical Society (Queensland Branch), Brisbane, Queensland (141); Mr. Samuel Davenport, Adelaide, S. Australia (141); Royal Society of Victoria, Melbourne (141); Public Library, Wellington, N. Z. (137, 138, 141); Societas pro Fauna et Flora Fennica, Helsingfors, Finland (142); Physico-Mathematical Society, Kasan, Russia (140, 141, 142); Tashkent Observatory, Tashkent, Russia (142); Prof. Dr. Japetus Steenstrup, Copenhagen, Denmark (142); Biblioteca N. C., Firenze, Italia (142); R. Istituto Lombardo di Scienze e Lettere, Milan, Italy (142); R. Accademia d. Scienze Lettere ed Arti, Modena, Italy (142); Società Africana d'Italia, Naples, Italy (142); Prof. Giuseppe Sergi, Roma, Italia (142); R. Osservatorio dell' Università, Turin, Italy (142); Marquis Antonio de Gregorio, Palermo, Sicily (141); Société R. de Geographie, Anvers, Belgique (133, 142); R. Accademia degli Agiati, Rovereto, Tyrol (139, 140, 141); Gesellschaft für Erdkunde, Berlin, Prussia (142); Naturhistorische Verein, Bonn (141); Naturwissenschaftliche Verein, Bremen, Germany (141); Naturforschende Gesellschaft, Emden, Prussia (141); Naturhistorische Gesellschaft, Hanover, Prussia (139, 141); K. Sternwarte, Leipzig, Saxony (141); Verein der Freunde der Naturgeschichte, Mecklenburg, Germany (141); K. Sternwarte, Munich, Bavaria (142); Naturwissenschaftliche Verein, Osnabrück, Prussia (141, 142); Bibliothèque Cantonale, Lausanne, Switzerland (142); Academia des Sciences et Belles Lettres, Angers, France (141); Société Linneenne, Bordeaux (142); Société d'Histoire et d'Archæologie, Chalon-sur-Saone, France (142); Société des Sciences Naturelles et Archéologiques de la Creuse, Guéret,

France (142); Bibliothèque Universitaire, Lyon, France (142); Faculté des Sciences, Marseille, France (114, 115, 116, and Catalogue, Parts i–iv); Société Francaise de Physique, Société de l'Histoire de France (144), Rédaction de "Cosmos" (142, 144), Ministre des Travaux Publics (138, 141), Compte de Charencey, M. Victor Duruy (144), Profs. E. Levasseur (142), E. Mascart (142, 144), Gaston Maspero (142, 144), Léon de Rosny (142), Marquis de Nadaillac (142), Paris, France.

Letters of acknowledgment (145) were received from Mr. Horatio Hale, Clinton, Ontario; Bowdoin College Library, Brunswick, Me.; Society of Natural History, Portland, Me.; Amherst College Library, Amherst, Mass.; Massachusetts Historical Society, Athenæum, Boston Society of Natural History, State Library of Massachusetts, Boston Public Library, Mr. Robert C. Winthrop, Boston, Mass.; Museum of Comparative Zoölogy, Profs. Alexander Agassiz, George L. Goodale, Mr. Robert N. Toppan, Dr. Justin Winsor, Cambridge, Mass.; Essex Institute, Salem, Mass.; Marine Biological Laboratory, Woods Hole, Mass.; American Antiquarian Society, Worcester, Mass.; Rhode Island Historical Society, Providence; Mr. George F. Dunning, Farmington, Conn.; Connecticut Historical Society, Hartford; Prof. O. C. Marsh, New Haven, Conn.; New York Historical Society, Meteorological Observatory, American Museum of Natural History, New York Hospital, Columbia College, Academy of Sciences, Hon. Charles P. Daly, Capt. R. Somers Hayes, Profs. Joel A. Allen, John J. Stevenson, New York, N. Y.; Prof. James Hale, Albany, N. Y.; Buffalo Library, Buffalc, N. Y.; Prof. Edward North, Clinton, N. Y.; Profs. J. M. Hart, Burt G. Wilder, Ithaca, N. Y.; Prof. W. Le Conte Stevens, Troy, N. Y.; Academy of Science, Rochester, N. Y.; Vassar Brothers' Institute, Poughkeepsie, N. Y.; Dr. W. T. Barnard, Boonton, N. J.; Free Public Library, Jersey City, N. J.; New Jersey Historical Society, Newark; Prof. W. Henry Green, Princeton, N. J.; Prof. Martin H. Boyé, Coopersburg, Pa.; Hon. Eckley B. Coxe, Drifton, Pa.; Rev. Thomas C. Porter, Prof. J. W. Moore, Dr. Traill Green, Easton, Pa.; Mr. John

Fulton, Johnstown, Pa.; Linnean Society, Lancaster, Pa.; Dr. D. G. Brinton, Media, Pa.; Academy of Natural Sciences, Engineers' Club, Historical Society of Pennsylvania, Mercantile Library, Wagner Free Institute, Numismatic and Antiquarian Society, Editor of *The Medical News*, Public Library, Library Company of Philadelphia, Hon. James T. Mitchell, Gen. I. J. Wistar, Revs. W. H. Furness, H. Clay Trumbull, Profs. John Ashhurst, Jr., Edward D. Cope, F. A. Genth, Jr., Lewis M. Haupt, H. W. Spangler, Drs. George Friebis, Morris Longstreth, Charles A. Oliver, C. N. Peirce, W. S. W. Ruschenberger, Charles Schäffer, William Thomson, Messrs. Richard L. Ashhurst, R. Meade Bache, Cadwalader Biddle, Lorin Blodget, Patterson DuBois, Jacob B. Eckfeldt, William A. Ingham, E. V. d'Invilliers, A. S. Letchworth, Robert Patterson, Henry Phillips, Jr., Franklin Platt, Theodore D. Rand, L. A. Scott, N. P. Tatham, Louis Vossion, Mrs. Helen Abbott Michael, Philadelphia; Prof. John F. Carll, Pleasantville, Pa.; Mr. Heber S. Thompson, Pottsville, Pa.; Dr. W. H. Appleton, Swarthmore, Pa.; Rev. F. A. Muhlenberg, Reading, Pa.; Philosophical Society, Hon. William Butler, Mr. Philip P. Sharples, West Chester, Pa.; Wyoming Historical and Geological Society, Wilkesbarre, Pa.

Accessions to the Library were reported from the Royal Society of New South Wales, Mr. N. A. Cobb, Sydney, Australia; Royal Geographical Society of Australasia, Melbourne; New Zealand Institute, Wellington; Geographical Society, Tokyo Library, Tokyo, Japan; Government Observatory, Madras, India; Société Phys.-Mathématique, Kasan, Russia; Société des Naturalistes de la Nouvelle Russie, Odessa; K. K. Mineralogische Gesellschaft, Comité Geologique, Physikalische Central Observatoriums, St. Petersburg, Russia; Bataviaasche Genootschap van Kunsten en Wetenschappen, Batavia, Java; K. Bibliotheek, K. Zoologisch-Botanische Genootschap, 'S Gravenhage, Holland; Société Hollandaise des Sciences, Musée Teyler, Haarlem, Holland; Friesch Genootschap voor Geschied. Oudheid en Taalkunde, Leeuwarden, Friesland; Maatschappij der Nederlandsche Letterkunde, Holland;

Société Batave de Philosophie Experimentale, Rotterdam, Holland; Naturforschende Verein, Brünn, Austria; Siebenbürgische Verein für Naturwissenschaften, Hermanstadt, Transylvania; Gesellschaft der Wissenschaften, K. K. Sternwarte, Prag, Bohemia; Physikalische Gesellschaft, Deutsche Geologische Gesellschaft, K. P. Geologische Landesanstalt und Bergakademie, K. P. Meteorologische Institut, Berlin, Prussia; Naturhistorische Verein, Bonn, Prussia; Physikalisch-Medicinische Societât, Erlangen, Bavaria; Naturwissenschaftliche Gesellschaft "Isis," Dresden, Saxony; Gesellschaft zur Beförderung der gesammten Naturwissenschaften, Marburg, Prussia; Verein der Freunde der Naturgeschichte, Mecklenburg, Germany; Württembergische Verein für Handelsgeographie, Stuttgart; Société de Physique, Geneva, Switzerland; Sociétâ Toscana di Scienze Naturali, "Il Nuovo Cimento," Pisa, Italy; Comitato Geologico d'Italia, Rome; Société Linnéene, Bordeaux, France; Société d'Histoire et d'Archéologie, Chalon-sur-Saone, France; Bureau des Longitudes, Société Zoologique, Société Française de Physique, Museum d'Histoire Naturelle, Société de l'Histoire de France, Société Philologique, Paris, France; M. Edward Piette, Saint-Quentin, France; British Association for the Advancement of Science, Zoölogical Society, Prof. Henry Wilde, London, Eng.; Natural History and Philosophical Society, Belfast, Ireland; Royal Irish Academy, Royal Dublin Society, Dublin, Ireland; Historical and Scientific Society of Manitoba, Winnipeg; Boston Public Library, Dr. Samuel A. Green, Boston, Mass.; Free Public Library, New Bedford, Mass.; Essex Institute, Salem, Mass.; Brooklyn Library, Brooklyn, N. Y.; Buffalo Library, Buffalo, N. Y.; American Geographical Society, New York, N. Y.; Geological Society of America, Rochester, N. Y.; Pennsylvania Geological Survey, Harrisburg; Franklin Institute, Editors of the *Pionier Verein*, Mr. Frederick Prime, Philadelphia; Wyoming Historical and Geological Society, Wilkesbarre, Pa.; U. S. Naval Institute, Annapolis, Md.; Johns Hopkins University, Baltimore, Md.; U. S. Department of Agriculture, Bureau of Ethnology, American Historical Association, U. S.

Geological Survey, Washington, D. C.; Mr. C. E. Jones, Augusta, Ga.; University of Nebraska, Lincoln; Instituto Fisico-Geografico y Museo Nacional, San José, Costa Rica, C. A.; Museo de La Plata, Argentine Republic, S. A.; Ministry of Foreign Affairs, Caracas, Venezuela, S. A.; South African Philosophical Society, Cape Town; Agricultural Experiment Stations, Manhattan, Kans., Madison, Wis.

A photograph for the Society's Album was received from Mr. H. A. Hill, Boston, Mass.

A circular from the R. Accademia delle Scienze, Turin, Italy, announcing the death of its President, Prof. Comm. Michele Lessona.

The deaths of the following members were reported to the Society:

Brugsch Bey, Berlin, Prussia; died September 10, 1894, æt. 67.

Prof. Heinrich Helmholtz, Charlottenberg, Germany; died September —, 1894.

Prof. William Dwight Whitney, New Haven, Conn.; died June 7, 1894, æt. 67.

Dr. William T. Barnard, Boonton, N. J.; died May 9, 1894.

Rear-Admiral Edward Yorke Macauley, Philadelphia; died September 14, 1894, æt. 68.

Dr. Robert Peter, Lexington, Ky.; died April 26, 1894, æt. 89.

On motion, the President was authorized and requested to appoint a suitable person to prepare the usual obituary notice for the late Admiral Macauley.*

Dr. Cope presented for the *Transactions* a paper on the "Taxonomy of the Ophidia," which was, on motion, referred to a Committee of three members, to be appointed by the President.†

Prof. Cope made an oral communication in reference to a late review in the *Archiv für Anthropologie* (Braunschweig,

* Dr. Persifor Frazer was subsequently appointed.

† Drs. Ryder, Chapman and Sharp were subsequently appointed.

1893) upon his views of the ancestry of man, pointing out the errors into which the reviewer had fallen.

Pending nominations Nos. 1273, 1274, 1276 to 1301, inclusive, and new nominations 1302 and 1303 were read.

And the Society was adjourned by the President.

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*Stated Meeting, October 5, 1894.*

President, Mr. Fraley, in the Chair.

Correspondence was submitted as follows:

Letters of envoy were received from the K. Sächsische Gesellschaft der Wissenschaften, Leipzig, Saxony; Royal Observatory, Greenwich, Eng.; Royal Statistical Society, Zoölogical Society, London, Eng.; Musée de La Plata, Argentine Republic.

Letters of acknowledgment were received from the Geological Survey of India, Calcutta (142); Norwegian Society of Science, Throndligen, Norway (141, 142); R. Academy of Sciences, K. Statistiska Central Byrån, Prof. A. E. Nordenskiöld, Stockholm, Sweden (144); Prof. J. J. S. Steenstrup, Copenhagen, Denmark (144); Royal Society of Sciences, Prague, Bohemia (137–141); Deutsche Geologische Gesellschaft, Berlin, Prussia (142); M. Otto Böhtlingk, Leipzig, Saxony (142); Verein für Erdkunde, Metz, Germany (141); K. Sternwarte, Munich, Bavaria (144); K. Geodätisches Institut, Potsdam, Prussia (142, 144); Württembergische Verein für Handels-Geographie, Stuttgart, Germany (141, 142, 144); Naturforschende Gesellschaft, Schweiz. Naturforschende Gesellschaft Bibliothek, Bern, Switzerland (144); Société Vaudoise des Sciences Naturelles, Lausanne, Switzerland (144); Musée Guimet (142, 144); Ct. de Charencey, Marquis de Nadaillac, Dr. Edward Pepper, Paris, France (144); Mr. Samuel Timmins, Arley, Coventry, Eng. (142, 144); Philosophical Society, University Library, Cambridge, Eng. (142, 144); Sir John Evans, Nash Mills, Hemel Hempstead, Eng. (144); Philo-

sophical and Literary Society, Leeds, Eng. (144); Royal Society (142, 144), Geographical Society (144), R. Meteorological Society (142, 144), R. Astronomical Society (142, 144), Linnean Society (142, 144), Geological Society (144), Society of Antiquaries (142), Microscopical Society (142), Royal Institution of Great Britain (142, 144), Meteorological Office (144), Zoölogical Society (144), Victoria Institute (142, 144), Prof. William Crookes (142), Mr. C. Juhlin Daunfelt (142, 144), Dr. W. H. Flower (142), Sir John Lubbock (144), Col. William Ludlow (142, 144), Sir James Paget (142, 144), Sir Rawson W. Rawson (142, 144), Sir Henry Thompson, London, Eng. (142, 144); Geographical Society, Prof. W. Boyd Dawkins, Manchester, Eng. (142, 144); Natural History Society, Newcastle upon Tyne, Eng. (142, 144); Mr. Alfred R. Wallace, Parkstone, Dorset, Eng. (142); Royal Geological Society of Cornwall, Penzance, Eng. (142, 144); Dr. Isaac Roberts, Crowborough, Sussex, Eng. (144); Sir Henry Bessemer, Surrey, Eng. (144); Yorkshire Geological and Polytechnic Society, Yorkshire, Eng. (142, 144); Royal Society (142), Prof. James Geikie, Edinburgh, Scotland (142, 144); Philosophical Society, Geological Society, Glasgow, Scotland (142).

Accessions to the Library were reported from M. N. A. Cobb, Sydney, Australia; K. N. F. Universitetet, Christiania, Norway; Gesellschaft für Anthropologie, Ethnologie, etc., Gesellschaft für Erdkunde, Berlin, Prussia; Naturhistorische Gesellschaft, Hanover, Prussia; Physikalische-ökonomische Gesellschaft, Königsberg; Institut Grand-ducal, Luxemburg, Germany; Verein für Erdkunde, Metz, Germany, Société Helvétique des Sciences Naturelles, Lausanne, Switzerland; Direzione General della Statistica, Ministero di Agricoltura, Institut International de Statistique, Rome, Italy; M. G. Monret, Nicet, France; Prof. Emil Levasseur, Paris, France; Ronsdon Observatory, Lyme Regis, Eng.; R. Cornwall Polytechnic Society, Falmouth, Eng.; Royal Observatory, Greenwich, Eng.; Lords Commissioners of the Admiralty, Linnean Society, London, Eng.; Natural History and Antiquarian Society, Penzance, Eng.; Nova Scotian Institute of Science,

Halifax; Université Laval, Quebec, Canada; Natural History Society, Montreal, Canada; Royal Society of Canada, Ottawa; Superintendent of City Trusts, Dr. D. G. Brinton, Mr. Henry Phillips, Jr., Philadelphia; Siemens and Halske Electric Company of America, Chicago, Ill.; Observatorio N. Argentino, Cordoba, Argentine Republic; Musée de La Plata, Argentine Republic.

The President reported the appointment of Dr. Persifor Frazer to prepare the obituary notice of the late Admiral Macauley.

Dr. J. Cheston Morris read a paper on "The Ethics of Solomon," as illustrated by the Book of Ecclesiastes, with a translation from the Septuagint.

Pending nominations Nos. 1273, 1274, 1276 to 1303 inclusive were read.

The Committee appointed April 20, 1894, "to consider the state of the Society," etc., made the following report.

PHILADELPHIA, October 5, 1894.

The Committee, appointed under the resolution adopted by the American Philosophical Society, April 20, 1894, "to take into consideration the state of the Society and to report whether any, and if any, what measures it may be expedient to take for increasing the resident membership of the Society, and promoting its usefulness, and whether in effectuating these purposes it may be necessary to amend the existing laws and regulations," beg respectfully to report that they have carefully considered the resolution and recommend that the following changes be made in the laws of the Society as most likely to attain the object of the resolution.

1. They recommend that Chapter I of the laws be abolished, which now stands as follows:

## CHAPTER I.

### OF THE MEMBERS, AND MANNER OF THEIR ELECTION.

SECTION 1. The election of members shall be by ballot, and shall form part of the stated business of the meetings on the third Fridays of February, May, October and December.

2. A member may, at any meeting, nominate in writing a candidate for membership, and the nomination so made may, in like manner, be con-

curred in by other members. The board of officers and council may also nominate candidates for membership; and such nominations shall be certified to the Society by minute thereof in writing, attested by the clerk of said board.

3. No person shall be balloted for, unless his nomination, with the names of the members proposing him, or the minute of the board of officers and council, made as aforesaid, shall have been publicly read to the Society at the two stated meetings preceding that at which the balloting takes place. Nor shall any person be deemed duly chosen unless three-fourths of the votes given shall be in his favor.

4. Before entering upon an election for members, one of the secretaries shall read the names of the several candidates; and any member may then, for the information of the Society, speak to their character and qualifications for membership.

5. The names of the candidates and their places of abode shall be designated on the ballots, and the names of the officers shall be called in the order of their seniority by the acting secretary, the members thereafter depositing their ballots. The name of a candidate struck from a ballot or not voted for shall be considered as a vote adverse to that candidate.

6. After all the other business of the meeting shall have been disposed of, the ballot box shall be opened by the secretaries, or in their absence by two tellers, to be appointed by the presiding member, who shall then declare to the Society the result of the poll.

7. The members are mutually pledged not to mention out of the Society the name of any candidate proposed, nor of any withdrawn or unsuccessful candidate; and the papers containing the names of the unsuccessful candidates shall be destroyed immediately after the election.

8. Every member, upon his introduction into the Society, shall be presented to the presiding officer, and shall subscribe the laws.

9. Such members as reside within ten miles of the hall of the Society, and such other members as desire to vote at the meetings and elections, shall pay an admission fee of ten dollars, and annually thereafter, on the first Friday of January, a contribution of five dollars. The payment of fifty dollars at one time, by a member not in arrears, shall exempt him from all future annual payments.

10. Members-elect, residing within ten miles of the hall, shall lose the right of membership unless they subscribe the laws and pay their admission fee within one year after their election. Any member liable to an annual contribution, who shall neglect or refuse to pay the same for the term of two years, shall be notified by the treasurer in writing, on or before the second Friday in January after such default, that his rights as a member are suspended; and, in case the said arrears, together with the contribution due on the first Friday in January after such notice, shall not be paid to the treasurer on or before the said last-named day, the membership of such defaulting member shall be forfeited, his name stricken from the roll, and reported to the Society by the treasurer.

11. On the Society being informed of the death of a member, the fact shall be entered on the records, and a member may be appointed to prepare an obituary notice of the deceased.

12. The obituary notices of members shall be read to the Society, and they shall be bound together whenever they are sufficiently numerous to form a volume.

That in the place of this, Chapter I shall read as follows:

## CHAPTER I.

### OF THE MEMBERS, AND MANNER OF THEIR ELECTION.

SECTION 1. The election of members shall be by ballot, and shall form part of the stated business of the meetings on the third Fridays of February, May, October and December.

No other business shall be transacted at such meetings until the balloting for the election of members is completed and the result thereof reported to the Society.

SECTION 2. A Committee on Nominations to consist of five members of the Society, not members of the Board of Officers and Council, shall be chosen by ballot on the third Friday of October in each year, to which Committee shall be referred all nominations of candidates for membership, and it shall consider and report from the lists of nominations so referred such persons as said Committee may deem worthy of election to membership. To make such recommendations the vote of the said Committee shall, for each person recommended, be unanimous.

The names of the persons so recommended for membership shall be posted in a convenient place for inspection in the hall of the Society for three weeks preceding the election of members.

SECTION 3. A member may, at any meeting, nominate in writing a candidate for membership, and the nomination so made may, in like manner, be concurred in by other members.

The nomination paper may contain a statement of the grounds upon which the proposed candidate is deemed worthy of membership, or may state merely his name, residence and occupation. The nomination papers shall be filed with the Secretaries and by them be immediately transmitted to the Committee on Nominations, be recorded in a book to be called the "Record of Nominations," and be reported to the Society at its next stated meeting and entered on the minutes.

SECTION 4. At the election of members at least twenty members shall be required for a quorum and any person recommended by the Committee on Nominations having a majority of the votes of the members present shall be deemed to be duly elected.

SECTION 5. The election shall be held by two tellers, to be appointed by the presiding member, who shall receive and count the votes and make report to the Society of the result of the election.

A proper number of tickets containing the names of the candidates favorably reported by the Committee on Nominations shall be printed under the direction of the Librarian, and be ready for distribution among the members at the time designated for holding the election.

SECTION 6. Such members as reside within thirty miles of the hall of the Society, and such other members as desire to vote at the meetings and elections, shall pay an admission fee of ten dollars, and annually thereafter, on the first Friday of January, a contribution of five dollars. The payment of one hundred dollars at one time, by a member not in arrears, shall exempt him from all future annual payments.

SECTION 7. Members-elect, residing within thirty miles of the hall, shall lose the right of membership unless they subscribe the laws and pay their admission fee within one year after their election. Any member liable to an annual contribution, who shall neglect or refuse to pay the same for the term of two years, shall be notified by the Treasurer in writing, on or before the second Friday in January after such default, that his rights as a member are suspended ; and, in case the said arrears, together with the contribution due on the first Friday in January after such notice, shall not be paid to the Treasurer on or before the said last-named day, the membership of such defaulting member shall be forfeited, his name stricken from the roll, and reported to the Society by the Treasurer.

SECTION 8. On the Society being informed of the death of a member, the fact shall be entered on the records, and a member may be appointed to prepare an obituary notice of the deceased.

SECTION 9. The obituary notices of members shall be read to the Society, and they shall be bound together whenever they are sufficiently numerous to form a volume.

2. That Chapter II, Section 5, which now stands :

5. No one shall be esteemed a qualified voter at the election, who has not subscribed the laws and paid the admission fee, or who is in arrears to the Society, *or has not attended a meeting during a whole year next preceding the election.*

shall be amended to read as follows:

SECTION 5. No one shall be esteemed a qualified voter at the election, who has not subscribed the laws and paid the admission fee, or who is in arrears to the Society.

3. That Chapter VII (Of the Officers and Council), Section 7, which now reads :

7. The president and senior secretary of the Society shall be, ex officio,

the president and clerk at their meetings; and *three* of their number shall be a quorum.

be amended so as to read:

SECTION 7. The President and Senior Secretary of the Society shall be, *ex-officio*, the President and Clerk at their meetings; and *seven* of their number shall be a quorum.

4. To change Chapter VIII (Of the Librarian), so that Section 3, which now reads:

3. He shall attend at the library at every meeting of the Society, and daily, excepting Sundays, from *10 A.M. to 1 P.M.*, except when allowed leave of absence by the presiding officer of the Society, and shall then, and at such other times as he may think proper, lend out to any resident member of the Society, who is not indebted to him for fines or forfeitures, any books belonging to the library, except the last volumes and loose numbers of periodical journals, and except recent donations made to the Society, which shall not be lent out; taking from each member borrowing a book an obligation, with a sufficient penalty, to return the same uninjured, within one month thereafter, subject to a fine of fifty cents at every stated meeting that shall occur after the limited period before he returns the book, and a forfeiture of double the value of the book, or of the set of which it is one, if not returned in six months after being borrowed.

so that it shall stand as follows:

SECTION 3. He shall attend at the library at every meeting of the Society, and daily, excepting Sundays *and legal holidays, from 10 A.M. to 3 P.M.*, except when allowed leave of absence by the presiding officer of the Society, and shall then, and at such other times as he may think proper, lend out to any resident member of the Society, who is not indebted to him for fines or forfeitures, any books belonging to the library, except the last volumes and loose numbers of periodical journals, and except recent donations made to the Society, which shall not be lent out; taking from each member borrowing a book an obligation, with a sufficient penalty, to return the same uninjured, within one month thereafter, subject to a fine of fifty cents at every stated meeting that shall occur after the limited period before he returns the book, and a forfeiture of double the value of the book, or of the set of which it is one, if not returned in six months after being borrowed.

That Section 9, which now stands as follows:

9. He shall receive an annual salary of *seven* hundred dollars, to be

paid monthly from the treasury of the Society, and his services shall commence on the first Monday after his election.

be amended to read :

SECTION 9. He shall receive an annual salary of *nine* hundred dollars, to be paid monthly from the treasury of the Society, and his services shall commence on the first Monday after his election.

That a new section be inserted at the close of the Chapter, as follows :

SECTION 10. The library shall be closed during the months of July and August, but members desiring to use the same shall be permitted to do so under such arrangements as may be made by the Committee on the Library.

5. To amend Chapter IX, Section 3, which now stands as follows :

3. The qualified voters present at any stated or special meeting shall be a quorum, and be competent to elect members, dispose of property, appropriate money, and award premiums ; but no property shall be alienated or encumbered, except by the vote of three-fourths of the qualified voters present, and given at two successive stated meetings. For the transaction of the ordinary business, the reception and reference of communications on literary, scientific, or other subjects, all other members present shall be deemed competent to act, and, in the absence of qualified voters, shall form a quorum.

so as to read :

SECTION 3. *Twenty* qualified voters present at any stated or special meeting shall be a quorum, and be competent to elect members, dispose of property, appropriate money, and award premiums ; but no property shall be alienated or encumbered, except by the vote of three-fourths of the qualified voters present, and given at two successive stated meetings. For the transaction of the ordinary business, the reception and reference of communications on literary, scientific, or other subjects, all other members present shall be deemed competent to act, and, in the absence of qualified voters, shall form a quorum.

All of which is respectfully submitted,

FREDERICK PRIME, *Chairman.*
W. P. TATHAM,
F. FRALEY,
GEORGE H. HORN.

Mr. Prime moved that the report of the Committee be made the stated business of the meeting to be held on Friday, October 19, 1894, and that the Secretaries be directed to print and distribute the report to the resident members before the next meeting.

The motion being seconded was carried.

And the Society was adjourned by the President.

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*Stated Meeting, October 19, 1894.*

President, Mr. FRALEY, in the Chair.

Correspondence was reported as follows:

Letters of envoy were received from the Geological Survey of India, Calcutta; Société R. des Sciences, Upsal, Sweden; K. Sächsiche Gesellschaft der Wissenschaften, Leipzig; K. Geodätisches Institut, Central Bureau der Internationalen Erdmessung, Potsdam, Prussia; Verein für Vaterländische Naturkunde in Würtemberg, Stuttgart; Academy of Science, St. Louis, Mo.

A letter was received from the R. Accademia delle Scienze, Torino, Italia, announcing the death of Ariodante Fa Cretti, one of its members.

Letters of acknowledgment were received from the Geological Survey of India, Calcutta (144); K. K. Central-Anstalt für Meteorologie, etc., Vienna, Austria (142, 144); Redaction der *Naturwissenschaftlichen Wochenschrift* (130, 134, 137); K. Akademie der Wissenschaften, Berlin, Prussia (144); Naturwissenschaftliche Verein, Bremen, Germany (142, 144); K. Sächs. Met. Institut, Chemnitz, Saxony (140, 142, 144); Geographische Gesellschaft, Hanover, Prussia (142); K. Sächs. Sternwarte (142, 144), Dr. Otto Böhtlingk, Leipzig, Saxony (144); Verein für Vaterländische Naturkunde in Würtemberg, Stuttgart (140, 141, and *Trans.*, xvii, 3, xviii, 1); Société R. des Sciences, Upsal, Sweden (137–141, and *Trans.*, xvii, 1, 2, , xviii, 1); Mr. Samuel Timmins, Arley, Coventry, England

(144); Royal Observatory, Edinburgh, Scotland (142, 144); Mr. Horatio Hale, Clinton, Canada (144); Bowdoin College Library, Brunswick, Me. (144); Dr. Justin Winsor, Cambridge, Mass. (142); Marine Biological Laboratory, Woods Holl, Mass. (142); State Library, Albany, N. Y. (142, 144); Prof. J. E. Oliver, Ithaca, N. Y. (144); Academy of Science, Rochester, N. Y. (144); Mr. Arthur Biddle (144), Dr. John H. Brinton (142), Mrs. Helen Abbott Michael (144), Messrs. J. G. Rosengarten (144), Julius F. Sachse (144), L. A. Scott (141, 144), Philadelphia; Prof. John F. Carll, Pleasantville, Pa. (144); Prof. J. T. Rothrock, West Chester, Pa. (144); U. S. Naval Institute, Annapolis, Md. (144); Bureau of Ethnology, Hon. William Strong, Washington, D. C. (144); Academy of Science, Austin, Texas (142, 144); University of Iowa, Iowa City (144); Agricultural Experiment Station, Manhattan, Kansas (141, 142, 144); Washburn College, Kansas Academy of Science, Topeka (144); Lieut. A. B. Wyckoff, Seattle, Wash. (144); Historical Society of Southern California, Los Angeles (144); Prof. Daniel Kirkwood, Riverside, Cal. (144); Bishop Crescencio Carrillo, Merida, Mexico (144); Observatoire Météorologique Central de Mexico, Observatorio Astronomico de Tacubaya (144); Commissao Geographica e Geologica de San Paulo, Brazil (136, 139, 140); Institute of Jamaica, Kingston (142).

Letters of acknowledgment (145) from the New Hampshire Historical Society, Concord; Vermont Experiment Station, Burlington; Rhode Island Agricultural Experiment Station, Kingston; Providence Franklin Society, Providence, R. I.; State Library, Albany, N. Y.; Agricultural Experiment Station, Geneva, N. Y.; Geological Society of America, Rochester, N. Y.; Oneida Historical Society, Utica, N. Y.; Prof. Robert W. Rogers, Madison, N. J.; Prof. Charles W. Shields, Princeton, N. J.; Dr. Charles B. Dudley, Altoona, Pa.; Prof. Lyman B. Hall, Haverford, Pa.; Mr. P. F. Rothermel, Linfield, Pa.; Dr. Persifor Frazer, Prof. H. D. Gregory, Philadelphia; Mr. Thomas Meehan, Germantown, Philadelphia; Enoch Pratt Free Library, Maryland Institute, Peabody Institute,

Baltimore, Md.; Mr. T. L. Patterson, Cumberland, Md.; U. S. Geological Survey, Library Surgeon General's Office, U. S. Weather Bureau, Messrs. John S. Billings, W. J. Hoffman, Garrick Mallery, Charles A. Schott, William B. Taylor, Washington, D. C.; University of Virginia, Leander McCormick Observatory, Prof. J. W. Mallet, University of Virginia, Va.; Mr. Jedediah Hotchkiss, Staunton, Va.; Agricultural Experiment Station, Raleigh, N. C.; Georgia Historical Society, Savannah; Newberry Library, Chicago, Ill.; Rantoul Literary Society, Rantoul, Ill.; State Historical Society, Iowa City; Prof. E. W. Claypole, Akron, O.; Cincinnati Observatory, O.; Journal Comparative Neurology, Granville, O.; Oberlin College Library, O.; Purdue Experiment Station, LaFayette, Ind.; State Historical Society of Wisconsin, Academy of Sciences, etc., Madison; Kansas Academy of Science, Topeka; University of California, Prof. Joseph Le Conte, Berkeley, Cal.; Historical Society of Southern California, Los Angeles; Lick Observatory, Mt. Hamilton, Cal.; Prof. Daniel Kirkwood, Riverside, Cal.; Nebraska State Historical Society, Lincoln; Colorado Scientific Society, Denver; University of Wyoming, Laramie; South Dakota Agricultural College, Brookings; Academy of Science, Tacoma, Wash.; Bishop Crescencio Carrillo, Merida, Mexico; Observatorio Astronomico Nacional, Don Mariano Barana, Mexico, Mex.

Accessions to the Library were reported from the New Hampshire Historical Society, Concord; Dr. Samuel H. Scudder, Mr. Andrew McFarland Davis, Cambridge, Mass.; Connecticut Historical Society, Hartford; Yale University, New Haven, Conn.; University of the State of New York, Albany; Academy of Sciences, Scientific Alliance, Profs. J. A. Allen, W. LeConte Stevens, Mr. James Douglas, New York, N. Y.; Academy of Science, Rochester, N. Y.; Pennsylvania State College, Harrisburg; College of Pharmacy, Oriental Club of Philadelphia, Messrs. MacCalla & Co., Mrs. Wistar, Philadelphia; Peabody Institute, Baltimore, Md.; U. S. Department of Agriculture, Treasury and War Departments, Washington, D. C.; Law School of Mercer University, Macon, Ga.; Uni-

versity of California, Berkeley; University of Wisconsin, Madison; Historical Society, Lincoln, Neb.; Geological Survey, Minneapolis, Minn.; Observatorio Astronomico y Meteorologico, San Salvador, Central America; Sociedad Cientifica Argentina, Dr. Estanislao S. Zeballos, Buenos Aires, South America; Observatorio Nacional Argentina, Cordoba, South America.

The death of Dr. Oliver Wendell Holmes (Boston) was announced, October 7, 1894 (æt. 86).

The proposed amendments to the Laws of the Society were taken up.

The Librarian stated that public notice had been given in the newspapers that the Society would consider same at this meeting, and furthermore, that printed copies of the said amendments had been sent to the members before the date of the meeting, and that the quorum required by the Laws was present.

Mr. Prime moved to consider Sections 1 to 5, Chapter I, inclusive, together. The motion was carried.

Mr. McKean moved to amend paragraph 2 of Section 1, to strike out "no other business shall be transacted at such meeting until the balloting for the election of members is completed and the result thereof reported to the Society," and to substitute instead at end of 1st paragraph, "and it shall have priority over all other business until the balloting be completed."

The President stated that, agreeably to the custom of the Society, if any amendments were agreed to, that the Law so amended must lie over for two weeks.

Mr. McKean's motion was put and carried.

Mr. McKean moved to strike out the words "not members of the Board of Officers and Council" from Section 2.

Mr. McKean moved to amend the same section by striking out the words "be *unanimous*" and inserting instead "there shall be an affirmative vote of at least *three* members of the Committee."

The members discussed the question of public posting of names in the Society's Hall.

Mr. Prime submitted the following substitute for Section 2:

SECTION 2. A Committee on Nominations to consist of six members shall be chosen by ballot at the Stated Meeting of the Society, to be held on the third Friday of November, 1894, of whom two shall serve for one year, two for two years, and two for three years, and annually thereafter on the third Friday in November, two members of said Committee shall be chosen by ballot to serve for three years, but the retiring members shall not be eligible for re-election, until a year from the expiration of their office. Any member not attending a meeting of the Committee for six months shall be deemed to have vacated his office. Vacancies in this Committee occurring from any cause whatever, shall be filled by appointments made by the President of the Society, or if there be no President in office, then by the senior Vice-President. To this Committee shall be referred all nominations of candidates for membership, and it shall consider and report from the lists of nominations so referred, such persons as said Committee may deem worthy of election to membership.

To make such recommendations, the vote of at least four members of said Committee shall be required. The names of the persons so recommended for membership shall be posted in a convenient place for inspection in the Hall of the Society for three weeks preceding the election of members.

Members spoke to the amendment.

Mr. Prime called for a vote on his amendment.

Dr. Cope offered the following amendment: "That a vote of three members of the said Committee shall be a majority."

The vote was taken on Mr. Prime's motion, and it was carried by 18 ayes, 4 nays.

Then on Mr. Prime's amendment, which was lost, ayes 9, nays 11.

The amendment of Dr. Cope was put and carried, ayes 12, nays 6.

Dr. Greene moved that, it is the sense of the Society that it is inexpedient to make any change in the method of electing its members, then withdrew the same and offered a resolution to postpone the further consideration of the amendments in order to introduce the above motion.

The motion was lost, 10 ayes, 11 nays.

Mr. McKean moved to strike out the words "not members of the Board of Officers and Council," which was debated and carried by a vote of 18 ayes and 8 nays.

Dr. Morris moved to strike out second paragraph of Section 2, and substitute as follows:

All nominations shall be open to inspection by members of the Society when the Hall is open, under charge of the Secretaries.

The Committee on Nominations shall hold stated meetings on the second Fridays of January, April, September and November, when those interested may state their reasons for or against any candidate: but the members of the Society are mutually pledged not to mention out of the Society the name of any candidate proposed, nor of any withdrawn or unsuccessful candidate : and the papers containing the names of unsuccessful candidates shall be destroyed immediately after the election following.

Dr. Cope moved that the words "the names of the persons so recommended for membership shall be placed in a convenient place for inspection in the Hall of the Society for three weeks preceding the election," be struck out.

Mr. Prime explained the reason of the paragraph.

Dr. Brinton moved to adjourn. The motion was lost ayes 7, nays 14.

The question being taken on Dr. Cope's motion, it was carried.

Dr. Greene moved to indefinitely postpone action on the amendments.

Mr. Prime moved to make the amendments prepared by the Committee the stated business of the next regular meeting.

It was moved to adjourn. Carried, ayes 17.

And so the Society was adjourned.

## *Some Coal Measure Sections Near Peytona, West Virginia.*

*By Benj. Smith Lyman.*

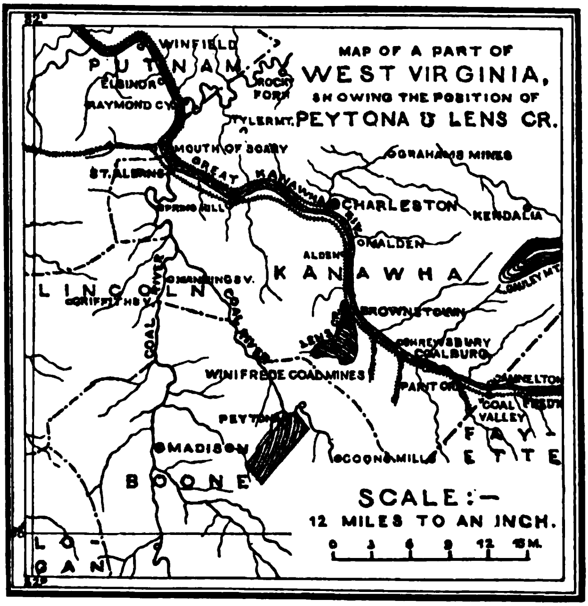
*(Read before the American Philosophical Society, November 2, 1894.)*

Some results of a couple of rough surveys made in 1872, near Peytona, Boone Co., W. Va., though without any addition from later observations, may be a useful contribution towards the elucidation of the geology of that region. The graphic comparison of columnar sections there with Prof. J. J. Stevenson's careful general section in the northern edge of that State, as published, without any diagram, in our *Transactions*, Vol. xv, p. 15, 1872, shows a remarkable general agreement, considering the great distance. The present sections also help very much in the identification of the different coal beds of the region, hitherto insufficiently studied, as remarked by Prof. I. C. White, in his valuable "Stratigraphy of the Bituminous Coal Field of Western Pennsylvania, Ohio and West Virginia," *U. S. Geol. Surv. Bulletin*, No. 65, p. 148, 1891.

It will be well to indicate first, with some precision, the situation of the tracts surveyed, and then briefly their main topographical features; before giving the geological details of the general structure and of the special observed facts, and pointing out the remarkable agreement of the resulting columnar sections with the distant northern section, and discussing the identification of beds that is consequently to be inferred.

### SITUATION.

The accompanying small map shows in a general way the situation of the two tracts and their relative position.



One of the surveys covered the tract owned by the Peytona Cannel Coal Company, at Peytona, on Coal River, thirty-five miles above Coalsmouth (or St. Alban's), on the Kanawha, and about twenty-two miles by road south of Charleston, the State capital, and twelve miles southerly from Brownstown. It is a tract of 6137 acres, in the shape nearly of an oblong square about five miles long by a mile and three-quarters wide, with the long sides running about northeast.

The other survey covered the two Parker tracts on Lens Creek (marked as Callacham's Creek, on some maps), both together about 6500 acres, and somewhat in the shape of a leg of mutton, or of a rather one sided oak leaf with the stem of the leaf or smaller end about a mile southwest of the mouth of the creek, near Brownstown, on the Kanawha, ten miles above (southwest of) Charleston, and with the eastern side running in a sinuous course southerly about three miles and a half, and the western side mainly following the course of the creek. The southwestern corner is about four miles northeast of Peytona.

### LAY OF THE LAND.

The land of both surveys has the same general topographical character that is found under like geological conditions throughout so large a region in West Virginia and western Pennsylvania, namely, very steep, often cliffy, hillsides and narrow valleys, with the hills rising 800 to 900 feet, or even more to summits that are mostly narrow, here and there even sharp, but in some places broad and flat, and with narrow strips of nearly flat land, up to a couple of hundred yards in width, along the lower and comparatively level parts of the streams. The lowest points in each survey are some 600 feet above sea level.

The Peytona tract is drained by Coal River, flowing westward across its northern end, and in the central part by Indian Creek, flowing northerly, the western edge by the eastern branches of Droddy's Creek, up as far as its Lick Fork at the southwest corner; and the southern corner by the head waters of the Sandy Lick Fork of Laurel Creek.

On the Parker tract, the lower part of Lens Creek, from its forks northeastward three-quarters of a mile to its mouth forms the stem of the oak-leaf shape, and the midrib of the leaf is the left fork of Lens Creek, with long side ribs and veinlets on the western side, and shorter ones on the east. A narrow strip besides is added along the west, containing the most eastern branches of the right fork of Lens Creek, which forms the western boundary. Both forks fall only fifty or sixty feet to the mile for four miles above their union; but above that much more rapidly.

### GEOLOGY.

STRUCTURE.—The geological structure that occasions the peculiar topographical character, with flat, table-like hilltops here and there, with flat valleys and with many cliffs on the almost uniformly abrupt hillsides is, of course, the very level bedding of a great thickness of rocks at a sufficient height above sea-level.

In the northern part of the Peytona tract, the rock beds seem to lie pretty regular, with the very gentle dip of 1 to 102, or 51¾ feet to the mile, southeasterly, and the strike of N. 14½° E. The same dip and strike perhaps continue throughout the southern part of the tract, but the lack of surveys there leaves this point uncertain. There are slight local variations from the general dip causing "swamps" in the mines, say one hundred yards across, and sinking, say, one or two feet; such swamps, however, as are common to all our western, flat-lying coal measures.

On the Parker tracts the dip is so slight that without much careful leveling it would be impossible to tell exactly what it is, or whether it is the same throughout the tracts. It seemed at the time of the survey and of drawing the map, to be in general uniform throughout them, and to be towards the north-northeast (N. 20° E.) about one foot in 78, or 68 feet to the mile. But there are local variations of the dip here, too, extending a few hundred yards, or at least "swamps" in the coal beds, depending on the varying thickness of the rock-layers.

It now seems, however, not improbable that the strike lines, drawn straight and parallel on the two large maps throughout the tracts of each survey, should have been gently curved as indicated by the lines of shading of the two surveys on the accompanying little map of their general situation, making the strike curves of one survey conform, by gradual transition, to those of the other, and to correspond with the northwesterly dip that is said to prevail at Coalburg, on the opposite, southeasterly side of the broad, shallow basin. The strike curves on Lens Creek would then be gently convex towards the northeast, and those of Peytona would be slightly so towards the east. Nevertheless, this little change would not affect the principal results of the surveys, nor the identification of the beds.

Rock-beds.—The following is a general section downwards of the rocks exposed on the Peytona tract, so far as known:

| | | FT. | IN. |
|---|---|---|---|
| Partly hidden, but chiefly sand rock and shales... | about | 155 | 0 |
| Gray clay | " | 1 | 0 |
| Coal, *Pittsburgh Bed*, with some slate | " | 4 | 0 |
| Hard fireclay and sand rock and shales | " | 23 | 0 |
| Coal, bituminous, soft | " | 0 | 4 |
| Fireclay and hidden, but no doubt mostly sand rock and shales | " | 85 | 0 |
| Coal, bituminous | " | 0 | 4 |
| Fireclay and hidden, but no doubt mostly sand rock and shales | " | 90 | 0 |
| Bony coal | " | 0 | 3 |
| Hidden, but no doubt chiefly sand rock and shales | " | 55 | 0 |
| Coal, bituminous, with two feet of fireclay in the middle | " | 5 | 0 |
| Hard, gray sand rock and hidden, but doubtless mostly sand rock and shales | " | 120 | 0 |
| Coal, bituminous | " | 0 | 6 |

| | | FT. | IN. |
|---|---|---|---|
| Hidden, but no doubt chiefly sand rock and shales | about | 13 | 0 |
| Black slate | " | 0 | 4 |
| COAL, bituminous | " | 0 | 2 |
| Shale, or slate | " | 0 | 4 |
| Sand and bituminous coal mixed | " | 0 | 9 |
| Iron ore (carbonate) | " | 0 | 0¼ |
| Slate and sand rock mixed | " | 0 | 8 |
| Black slate | " | 0 | 5 |
| Cannel slate ("bastard cannel") | " | 0 | 1 |
| Slate | " | 0 | 1 |
| Fireclay | " | 0 | 2 |
| Cannel slate ("bastard cannel") | " | 0 | 1½ |
| Fireclay | " | 0 | 2 |
| COAL, *Upper Cannel*, all "smooth cannel" | " | 2 | 6 |
| Cannel slate ("bastard cannel"), with fossil shells | " | 0 | 2¼ |
| Sand rock and sandy shales | " | 15 | 0 |
| Slate | " | 0 | 6 |
| Iron ore | " | 0 | 0½ |
| Slate and iron ore mixed | " | 1 | 0 |
| Iron ore | " | 0 | 0 |
| Slate | " | 0 | 10 |
| Shale | " | 0 | 4 |
| Cannel slate | " | 0 | 2 |
| Fireclay | " | 0 | 2 |
| COAL, *Main Cannel*, partly bituminous | " | 2 | 10 |
| "Slate" | " | 1 | 0 |
| "Bastard cannel" | " | 0 | 5 |
| "Slate" | " | 1 | 0 |
| "COAL," bituminous | " | 0 | 7 |
| Hidden, but no doubt mostly sand rock and shales | " | 89 | 0 |
| COAL, *Shoot Bed* | " | 3 | 6 |
| Hidden, but doubtless chiefly sand rock and shales | " | 17 | 0 |
| Sand rock | " | 4 | 0 |
| Sandy shales | " | 2 | 0 |
| COAL, *Blacksmith Bed* | " | 2 | 0 |
| Fireclay and brownish gray sand rock | " | 6 | 0 |
| Sand rock and shales | " | 37 | 0 |
| Brown shales with small iron-ore balls | " | 20 | 0 |
| Black slate | " | 0 | 8 |
| Shales and sand rock | " | 27 | 6 |
| Sand rock, very cross bedded, brownish gray | " | 9 | 0 |
| COAL, bituminous | " | 0 | 3 |
| Sand rock, brownish gray, Penna. Formation No. XII | | | |
| | | 800 | 0 |

The following is a general section downwards of the rocks exposed on the Parker or Lens creek tracts, so far as known :

| | | FT. | IN. |
|---|---|---|---|
| Gray sand rock | about | 8 | 0 |
| Hidden | " | 30 | 0 |
| COAL, *Pittsburgh Bed,* 4,, 9 to 5,, 6, say | " | 5 | 0 |
| Hidden | " | 44 | 0 |
| Brownish-gray sand rock | " | 4 | 0 |
| Hidden | " | 14 | 0 |
| Slates | " | 6 | 0 |
| COAL, *Slate Vein,* in two or three thin layers separated by much clay, the upper one cannel, average, say | " | 3 | 0 |
| Hidden | " | 190 | 0 |
| Brownish gray sand rock | " | 5 | 0 |
| Hidden | " | 105 | 0 |
| COAL, *Wood's Upper Bed,* with commonly about half an inch of clay at about six inches below the top, 2,, 6(?) to 4,, 0, average, say | " | 3 | 0 |
| Hidden | " | 7 | 0 |
| Brownish-gray sandy shales and sand rock | " | 37 | 0 |
| COAL, *Factory Bed,* 0,, 9 to 3,, 8, with about two thickish layers of clay, average | " | 3 | 0 |
| Brownish-gray sandy shales | " | 21 | 0 |
| Hidden | " | 20 | 0 |
| Brownish-gray sand rock | " | 10 | 0 |
| Hidden | " | 4 | 0 |
| Brownish gray sand rock | " | 12 | 0 |
| COAL, *Wood's Lower Bed,* commonly with a half-inch seam of clay about five inches above the bottom, 3,, 3½ to 4,, 0½, average, say | " | 3 | 8 |
| Slate floor of coal and hidden | " | 22 | 0 |
| COAL, a very thin seam, say | " | 0 | 4 |
| Black slate | " | 2 | 0 |
| Hidden | " | 24 | 0 |
| Brownish-gray sand rock | " | 12 | 0 |
| Hidden | " | 6 | 0 |
| Brownish-gray sand rock | " | 5 | 0 |
| Brownish-gray sandy shales, sometimes with small iron ore balls | " | 15 | 0 |
| COAL, *Jerrold's Bed,* with sometimes a half-inch layer of clay at about nine inches below the top, sometimes one near the bottom also ; 2,, 8, or even less to 3,, 6, average, say | " | 3 | 0 |
| Brownish-gray sandy shales | " | 14 | 0 |
| COAL, *Vicker's Bed,* perhaps | " | 2 | 0 |
| | | 640 | 0 |

### COAL OPENINGS.

PITTSBURGH COAL.—The Pittsburgh coal bed has been opened at only one place on the Peytona tract or in the neighborhood; and that was near the top of the mountain above the mines and east of them. The section measured there was as follows, from above downward:

| | FT. | IN. | FT. | IN. |
|---|---|---|---|---|
| Loose sandstone blocks, somewhat limy? | | | | |
| Sand rock, thick | | | | |
| Hard gray clay | 1 | 0 | | |
| Good COAL | 0 | 11½ | | |
| Slate | 0 | 2 | | |
| COAL and slate mixed | 1 | 4 | | |
| Slate | 0 | 2 | | |
| Good COAL | 0 | 8½ | 4 | 0 |
| Slate | 0 | 3½ | | |
| COAL | 0 | 0½ | | |
| Slate | 0 | 1 | | |
| Good COAL | 0 | 3 | | |
| Fireclay | | | | |
| | 5 | 0 | | |

The coal bed contains, then:

| | FT. | IN. |
|---|---|---|
| Good coal | 1 | 11 |
| Slaty coal | 1 | 4 |
| Slate | 0 | 9 |
| | 4 | 0 |

That is, however, so much inferior both in thickness and in quality to what the same bed is even as near as Lens Creek, and still more to what it is in the northern part of the State, that it seems not unreasonable to hope that its average throughout the tract may prove better than at this opening.

On Lens creek the bed forms but small patches on the hilltops, and has (1872) been opened in only one place, namely, on the hill opposite Mrs. Nuby's house and King's Hollow, about the middle of the eastern edge of the map; with the following section, from above downward:

| | FT. | IN. |
|---|---|---|
| Loam, with crop-coal | | |
| COAL | 1 | 9 |
| Clay | 0 | 6 |
| COAL, with half-inch layers of clay at about four and six inches from the bottom, and perhaps at about a foot and a foot and a half from the bottom | 3 | 4 |
| | 5 | 7 |

The opening is not a very perfect one, and perhaps does not show the

full thickness. The quality is only imperfectly shown, as the coal dug had no solid cover and is all mere crop-coal, yet seems to be good.

The bed has been worked at Curry's mine, in Church Hollow, about one hundred yards outside the Parker tracts, and just outside the northeastern corner of the Lens Creek map; with the following section from above downward:

| | FT. | IN. |
|---|---|---|
| Sand rock | | |
| COAL | 1 | 5 |
| Gray slate | 0 | 2 |
| COAL | 3 | 2 |
| Fireclay | | |
| | 4 | 9 |

The SIX-INCH BITUMINOUS COAL bed about twenty-three feet below the Pittsburgh bed at Peytona, was opened in June, 1872, on the lumber slide above the No. 1 Entry of the old Peytona mines.

The FOUR-INCH SOFT, BITUMINOUS COAL bed about one hundred and ten feet below the Pittsburgh bed, at Peytona, was opened in June, 1872, on the lumber slide above the No. 1 Entry of the old Peytona mines, with a fine-looking bed of fireclay partly exposed below.

SLATE VEIN.—The slate vein on Lens Creek was opened by an old drift, near Curry's coal mine in Church Hollow, just outside the northeast corner of the map; and measured as follows, from above downward:

| | FT. | IN. | FT. | IN. |
|---|---|---|---|---|
| Slates, exposed some | 6 | 0 | | |
| Coal, cannel | 1 | 2 | | |
| Black slate | 1 | 0 | | |
| COAL, soft, bituminous, more than half under water, about | 1 | 3 | 3 | 5 |
| | 9 | 5 | | |

The same bed was also opened in June, 1872, on the hillside up the hollow opposite Mrs. Nuby's house and King's Hollow on the Left Fork of Lens Creek, below the opening of the Pittsburgh bed there; and measures as follows, from above downward:

| | FT. | IN. |
|---|---|---|
| Clay, gray, perhaps not in place | | |
| COAL, cannel, slaty | 0 | 8 |
| Brown slate or clay, with a little coal | 0 | 5½ |
| Coal, bituminous | 1 | 0 |
| Gray clay | 0 | 5½ |
| COAL, bituminous | 0 | 8 |
| | 3 | 3 |

The THREE-INCH BONY COAL about two hundred feet above the upper cannel coal bed was opened above Entry No. 4, at Peytona, in 1872; but only showed two or three inches of bony crop-coal, or crop-cannel, or perhaps merely crop-slate.

The THREE-FOOT BITUMINOUS COAL bed about one hundred and forty feet above the upper cannel on the Peytona tract, has been partially opened above Entry No. 4, with the following section from above downward:

| | FT. | IN. |
|---|---|---|
| Loam ... about | 2 | 0 |
| Crop-COAL, splint-like ... | 1 | 0 |
| Fireclay ... | 1 | 5 |
| COAL, bituminous, firm and good ... | 2 | 6 |
| | 6 | 11 |

It may prove workable in some places, but cannot probably be counted on as such throughout the tract. It is most likely the same as a bed of unworkable thickness that has been opened on the waters of Indian creek, either the "Third Cannel," in Abshire's Hollow and on Meadow's Fork (a bed yielding there about seven inches of cannel at the bottom with bituminous coal above it), or a thin bed of bituminous coal said still more to resemble it, formerly opened some twenty feet higher up, on Meadow's Fork.

The SIX-INCH BITUMINOUS COAL some twenty feet above the upper cannel was opened on the top of the point on the south side of Droddy's Creek, near the western edge of the map; and is said to have been six inches thick, pretty firm, but not splint-like, without solid roof, but about two feet of rather hard clay above it. The same bed shows about three inches of outcrop, without solid roof or floor, about thirty-two feet above the bottom of Entry No. 4, of the Peytona mines and on the north side of the hollow.

UPPER CANNEL.—The thicknesses of the beds in the general section within three or four feet above the Upper Cannel bed are the means of measurements at two places; except that the thickness given for the principal cannel bench is the average of four measurements near the mines. That bench, however, is still more variable hereabouts. It has been worked at the Peytona mines by a short drift, on which it measures twenty-seven inches and about thirty-one inches; and has also been opened by a slope from the Main Cannel bed and measures there twenty-one inches.

On Abshire's Branch of Indian Creek, half a mile southeast of the Peytona mines, the same bed is opened in several places, and at one of them measures as follows, from above downward:

| | FT. | IN. |
|---|---|---|
| Slate ... | | |
| COAL ... | 0 | 6 |
| Brownish-gray sand rock ... about | 3 | 6 |
| Brown shales ... " | 1 | 6 |
| Cannel COAL ... " | 1 | 11 |
| Shales, exposed ... " | 0 | 3 |
| | 7 | 8 |

At another opening, about two hundred yards further up the branch and on its north side, the following section with the same bed is exposed from above downward:

| | FT. | IN. |
|---|---|---|
| COAL, bituminous, "hard," merely the tail of the outcrop | 0 | 9 |
| Slate | 2 | 0 |
| Cannel COAL | 1 | 3 |
| | 4 | 0 |

At an opening about thirty yards distant on the south side of the branch the Upper Cannel is about ten inches thick, but it is only the tail of the outcrop not well roofed over.

An opening was made on the Upper Cannel in June, 1872, back of John McCarty's house on Droddy's creek, in the western edge of the tract, and gave the following section from above downward:

| | | FT. | IN. |
|---|---|---|---|
| Sand rock, massive | about | 2 | 0 |
| Shales | " | 3 | 0 |
| COAL, soft, rotten, bituminous | " | 0 | 6 |
| Clay | " | 0 | 6 |
| Black slate | " | 0 | $0\frac{1}{4}$ |
| CANNEL, the upper inch perhaps a little bony | " | 3 | $2\frac{3}{4}$ |
| | | 9 | 3 |

The Upper Cannel was also opened in 1872 on the hillside over the blacksmith's shop on Droddy's Creek, half a mile northwesterly from the mines, and measures but $10\frac{1}{2}$ inches, of which only the upper nine-eighths of an inch are cannel or cannel slate, the rest all bituminous; but there was only clay and loam above, without any solid roof.

The quality of the cannel coal of this bed at Peytona is very good, though not quite equal to the remarkably fine coal of the Main Cannel bed.

On Lens Creek the Upper Cannel coal bed is of different character, but is beyond question the bed called there Wood's Upper Coal. It seemed in 1872 to have been worked only at Wood's upper mine on King's branch, where it was opened by a drift about twenty feet long in the winter of 1869 and 1870, with the following section from above downward:

| | | FT. | IN. |
|---|---|---|---|
| COAL, bituminous, softer | about | 0 | 9 |
| Clay | " | 0 | $0\frac{1}{4}$ |
| COAL, bituminous, hard, "splint" | " | 2 | 8 |
| | | 3 | $5\frac{1}{4}$ |

It was not then fully accessible on account of water dammed back by fallen earth at the mouth.

The same bed was imperfectly opened at the head of Big Hollow, in 1872, with the following section from above downward :

| | | FT. | IN. | FT. | IN. |
|---|---|---|---|---|---|
| Loose clay and shaly wash | about | 2 | 0 | | |
| COAL, much weathered, rather hard | " | 0 | 6 | | |
| Clay | " | 0 | 0½ | 3 | 9 |
| COAL, hard and firm, but weathered | " | 3 | 2½ | | |
| Black slate, exposed | " | 0 | 1 | | |
| | | 5 | 10 | | |

The same bed was opened in 1872 on the very steep hillside on the south side of Schoolhouse Hollow, near the middle of the east edge of the map, with the following section from above downward :

| | | FT. | IN. | FT. | IN. |
|---|---|---|---|---|---|
| Slate roof exposed | about | 2 | 0 | | |
| COAL, softer | " | 0 | 5½ | | |
| Clay | " | 0 | 0¼ | 3 | 3¾ |
| COAL, hard, "splint" | " | 2 | 10 | | |
| | | 5 | 3¾ | | |

Floor, said to be slate, two inches under water.

Another opening made on the same bed in 1872, on Bee Branch, near the southern edge of the map, gave the following section from above downward :

| | | FT. | IN. | FT. | IN. |
|---|---|---|---|---|---|
| Slate | about | 1 | 0 | | |
| COAL, rather soft | " | 0 | 4½ | | |
| Clay | " | 0 | 1 | 3 | 3 |
| COAL, bituminous, hard, "splint". | " | 2 | 9½ | | |
| Brownish-gray, fine, hard sand rock | " | 1 | 0 | | |
| | | 5 | 3 | | |

A rather imperfect opening made on the same bed in 1872 nearly opposite Nuby's house on the left fork of Lens Creek had the following section from above downward :

No roof but loose material, mostly brownish-gray sandstone blocks.

| | | FT. | IN. |
|---|---|---|---|
| COAL, bituminous | | 0 | 3½ |
| Gray clay | about | 0 | 1½ |
| COAL, bituminous | | 2 | 1 |
| Bony COAL | | 0 | 6 |
| COAL, bituminous | | 0 | 6 |
| | | 3 | 6 |

Another opening on the same bed made imperfectly in 1872 at Perfater's Spring, on a small branch of the left fork of Lens Creek, nearly

south of Lavender's house, gave the following section from above downward:

No roof but wash.

| | FT. | IN. |
|---|---|---|
| Coal, slaty.................................about | 0 | 1 |
| Coal, with half an inch of clay about the middle, " | 0 | 11 |
| Hard fire clay. | | |
| | 1 | 0 |

The spring is only about three feet distant. Its water is called good, but said to taste a little sulphury.

It is probably the same bed that was very poorly opened in 1872 rather high up the hillside in Peels' Hollow, with the following section from above downward:

| Wash loam. | FT. | IN. | FT. | IN. |
|---|---|---|---|---|
| Coal.................................... | 0 | $3\frac{1}{2}$ | | |
| Clay.................................... | 0 | $1\frac{1}{4}$ | | |
| Coal.................................... | 1 | $6\frac{1}{2}$ | 2 | 2 |
| Clay.................................... | 0 | $0\frac{3}{4}$ | | |
| Coal.................................... | 0 | 2 | | |
| Clay, exposed.....................about | 0 | 6 | | |
| | 2 | 8 | | |

The coal is only bituminous, and nothing but dirty crop-coal, and so not of very good appearance.

The bed was also opened in 1872 near Asa Ferrel's house, and near the southwest corner of the map, just above the so-called Ferrel's coal opening on the Factory Coal Bed, or the Peytona Main Cannel, and had the following section from above downward:

| Roof, not solid. | FT. | IN. |
|---|---|---|
| Coal, bituminous, "splint"........................ | 0 | 6 |
| Fireclay.............................................. | 0 | 6 |
| Coal, bituminous, "splint"........................ | 1 | 6 |
| | 2 | 6 |

The coal of Wood's Upper Bed is bituminous, of very fine quality, especially the main bench, below the seam of clay. The main bench is a remarkably firm splint coal, extremely well suited for steam purposes or domestic fires, or probably even for burning raw in iron furnaces. It is easily mined in large blocks that bear rough handling extremely well. A fair specimen of it was assayed in 1872 by the very able chemist, Dr. George A. Koenig, and yielded:

| | |
|---|---|
| Coke................................................ | 68.35 |
| Gas................................................. | 23.25 |
| Ashes (gray)........................................ | 6.45 |
| Hygroscopic water.................................. | 1.95 |
| | 100.00 |

The coal seems to be very free from sulphur. The thin upper bench is less firm than the main one. This bed is undoubtedly the one described in the following extracts from a report on these tracts by the celebrated Professor James Hall (1854), as quoted in the pamphlet of the St. George Mining and Manufacturing Company, New York, 1865, page 7:

"This bed was first opened on the point of a low hill in the rear of Mr. Vickar's house, as shown on the map. At this point it is three feet ten inches thick. Although in a most exposed situation, and covered only by a slight thickness of clay, the coal was quarried out in blocks of large size, and breaking into smaller masses only by the application of considerable force.

"The aspect of the coal is that of a laminated cannel coal with thin seams of bituminous coal intervening, but altogether forming a small part of the whole. On burning this coal side by side with the cannel coal from the bed previously mentioned, there was a remarkable similarity in the color and character of the flame, the amount of smoke and the ash. The coal burns with much white, or yellowish-white flame, without decrepitation, and with a small quantity of smoke. It maintains its form, showing no disposition to melt or run, and in the process of burning, throws out numerous jets of white flame, in addition to the steady burning flame. When partially burned, it presents a fine porous coke, finally burning away to a white or light-colored ash, without, in the cases tried, any appreciable quantity of slag or other impurity. The flame and quantity of smoke from a piece of cannel coal burned at the same time and by the side of this coal were not perceptibly different.

"From this little experiment, twice repeated at the locality, I infer that for all purposes for producing steam, or for a steady, dry-burning, blazing coal, the coal from this bed will answer all the purposes of the real cannel coal, and for these objects will be equally valuable. The only advantage possessed by the cannel coal for domestic use is that of its freedom from soiling in the process of handling. I am inclined, therefore, to regard this bed of coal as of very great value, particularly upon the western rivers, and for the steam boilers of all manufactories where the prevailing coals are of the soft, bituminous character.

"I may mention that such is the indestructibility of this coal from ordinary atmospheric agencies, that large fragments may be picked up in the beds of the streams half a mile from the coal in place, and the specimens burned were of such samples which had lain exposed to the weather probably for centuries. I need scarcely mention that from this remarkable indestructibility of the coal from the agency of the weather and from its breaking out in large blocks, even on the exposed outcrops, it is remarkably adapted to bear transportation with little loss from breaking or waste.

"This combination of qualities, which I hesitate not to say is possessed by no other coal in this region, except the cannel coal, renders it extremely valuable to any parties who propose to mine and send coal to market."

The bed seems to thin out, not only southwestward towards Peytona, but northwestward towards the Kanawha ; for near the river it measures but 2 feet 10 inches in one place, and would seem to be much less than that in Church Hollow and thereabouts. At the few points, however, where fully opened on the Parker tracts, it seems to be of good workable thickness ; and the bed seems to have its greatest size just here, and to be in general little noticeable everywhere else in the neighborhood.

The "bastard cannel" at the bottom of the upper cannel coal bed, at Peytona, contains numerous fossil shells.

MAIN CANNEL.—The Main Cannel coal bed had, in 1872, been worked for twenty years or more at the Peytona mines and near them, as well as at the adjacent mines of the Western Mining and Manufacturing Company. Seven measurements of the coal at different parts of the Peytona mines give the following section of the bed from above downward ;

| | FT. | IN. | FT. | IN. |
|---|---|---|---|---|
| Smooth cannel, 1,, 8 to 2,, 1, average, about | 1 | 10 | 2 | 6 |
| Curly (or birds'-eye) cannel, 0,, 0 to 1,, 6 | 0 | 8 | | |
| Bituminous coal, 0,, 0 to 0,, 8 | 0 | 4 | 0 | 4 |
| | 2 | 10 | 2 | 10 |

After those measurements were made, another part of the mine yielded cannel, both kinds together, 3 feet 5 inches thick, the lower 17½ inches being curly and the rest all good cannel.

An opening on the river front of the hillside over Halsted's farm about three-quarters of a mile northeast of the mines shows the following section from above downward :

| | FT. | IN. | FT. | IN. |
|---|---|---|---|---|
| Brownish-gray slate....about | 8 | 0 | | |
| Wild cannel or very bony cannel, or cannel slate | 0 | 1 | | |
| Clay | 0 | 1 | | |
| CANNEL, the lower inch a little mixed with bituminous coal | 0 | 5 | | |
| COAL, bituminous, very hard | 0 | 9 | | |
| Clay | 0 | 1 | 1 | 11 |
| COAL, bituminous, very hard, somewhat resembling "curly cannel" | 0 | 7¼ | | |
| | 10 | 1¼ | | |

In Abshire's Hollow, about half a mile southeast of the mines, the bed is opened, with the following section from above downward :

| | FT. | IN. |
|---|---|---|
| Smooth CANNEL | 0 | 3 |
| COAL, hard bituminous | 0 | 11 |
| Smooth CANNEL | 0 | 10 |
| | 2 | 0 |

An opening near Droddy's Creek, about three-quarters of a mile northwesterly from the Peytona mines, gives the following section from above downward :

| | FT. | IN. |
|---|---|---|
| CANNEL, slaty | 0 | 6 |
| COAL, bituminous | 0 | 3 |
| COAL, bituminous, resembling "curly cannel" | 1 | 1 |
| COAL, bituminous | 0 | 6 |
| | 2 | 4 |

Near John McCarty's house on Droddy's Creek, about twenty feet below the opening on the Upper Cannel, there is an old opening quite fallen in that must have been on the Main Cannel ; but its coal is said to have been "bituminous mixed with cannel."

The smooth cannel is cannel proper ; the curly cannel is an intimate mixture of cannel coal and bituminous. The curly is more highly prized, as it makes the best coal for domestic use. The quality of both kinds is remarkably pure. Besides the very great merits of the coal for domestic purposes, it is very valuable for making gas, owing to the large yield and high candle power of the gas ; and the coal is therefore used as an "enricher" with bituminous gas-coal.

The following are the results of an assay of the Peytona cannel coal, as reported by the Manhattan Gas Light Company of New York, in 1869 :

"Maximum yield of gas per ton of 2240 pounds—13,200 cubic feet of 32.66 candle power.

"At 10,000 feet per ton (standard yield) the illuminating power of the gas is equal to 41.16 candles.

"Yield of coke per ton, 32 bushels, weighing 1380 pounds.

"One bushel of the hydrate of lime purifies 4510 cubic feet of gas.

"Analysis of the coal :

| | |
|---|---|
| "Volatile matter | 46.00 |
| "Fixed carbon | 41.00 |
| "Ash | 13.00 |
| | 100.00" |

The cannel coal of the Main Bed has in some parts of the mine red ash, and in some parts white ash. At one place there is what they call "gummy coal" or "gum," red and white, said to be liquid when fresh, like syrup, thinner than cold molasses. Some of it when gathered dry in the mine looks like a rotten coal, and some of it like a bituminous powder.

In mining, the bituminous coal was thrown aside in the mine, and left there.

This bed is the same as the Factory Cannel Coal Bed of Lens Creek, but much superior to it in quality, as well as thickness, at the Peytona mines. It is a very irregular bed both in thickness and quality, and its unusual

merits in these respects at Peytona gave especial value to the deposit there.

The Factory Cannel Coal Bed was the most widely known of all the coals on Lens Creek, and is the one formerly worked at the old oil factory on the Left Fork. The section there, at about twenty-five yards inside the middle one of three drifts, is as follows, from above downward :

| | FT. | IN. | FT. | IN. |
|---|---|---|---|---|
| COAL, bituminous | 0 | 6 | 3 | 8½ |
| Black slaty clay | 0 | 9½ | | |
| Cannel | 2 | 5 | | |
| Black iron ore ........about | 0 | 3 | | |
| | 3 | 11½ | | |

The bench of cannel however is said to yield only 1 foot 6 inches of good cannel, the rest being "wild cannel" or cannel shale.

The same bed was imperfectly opened in 1872 nearly opposite Nuby's house on the Left Fork of Lens Creek and had the following section from above downward :

| | FT. | IN. |
|---|---|---|
| No solid roof. | | |
| CANNEL, partly good, partly slaty, all rather poor looking ........about | 3 | 0 |
| Black carbonate of iron | 0 | 2 |
| Brownish-gray sand rock, at least | 20 | 0 |
| | 23 | 2 |

The coal looks rather less pure than the Peytona mine cannel, but that is perhaps owing to its being merely crop-coal. The thickness, too, could not be properly measured without a firm roof.

The bed was opened also in 1872 near the schoolhouse of the Left Fork, with the following section from above downward :

| | FT. | IN. | FT. | IN. |
|---|---|---|---|---|
| Shaly sandrock ........about | 22 | 0 | | |
| Black clay ........ " | 0 | 1 | | |
| COAL ........ " | 0 | 1 | | |
| Black clay ........ " | 0 | 1 | | |
| Sand rock ........ " | 2 | 0 | | |
| Gray shales ........ " | 12 | 0 | | |
| Black soft slate ........ " | 0 | 6 | | |
| COAL, bituminous | 0 | 4½ | 0 | 9 |
| Clay | 0 | 1 | | |
| COAL, bituminous | 0 | 3 | | |
| Bright CANNEL | 0 | 0½ | | |
| Gray slaty clay | 1 | 6 | | |
| Shaly sand rock ........about | 10 | 6 | | |
| | 56 | 6 | | |

The same bed apparently was imperfectly opened in 1872, near the head of Stewart Branch, and had the following section from above downward:

| | FT. | IN. |
|---|---|---|
| Loam, no firm roof.......................... about | 2 | 0 |
| Clay, mixed with coal slate, outcrop........... " | 0 | 6 |
| Fire clay .................................. " | 1 | 6 |
| COAL, bituminous.............................. | 0 | 7 |
| | 4 | 7 |

The same bed was imperfectly opened too, in 1872, in Locust Hollow, east of the Right Fork, and had the following section from above downward:

| | FT. | IN. |
|---|---|---|
| No true roof, but clay and wash................ about | 2 | 0 |
| Crop-coal........................................ | 0 | 7 |
| Clay and wash.................................... | 0 | 6 |
| COAL, bituminous ................................ | 1 | 5 |
| Fireclay ...................................... about | 0 | 1 |
| COAL, bituminous................................. | 0 | 7 |
| | 5 | 2 |

The same bed was well opened in 1872, above Asa Ferrel's house, near the southwest corner of the map, with the following section from above downward:

| | FT. | IN. | FT. | IN. |
|---|---|---|---|---|
| Gray and brown shales................. | 2 | 5 | | |
| Hard black slate...................... | 0 | 1 | | |
| Gray and brown shales ................ | 0 | 6 | | |
| COAL, bituminous, good................ | 0 | 2 | | |
| CANNEL, good, but not curly........... | 0 | 5 | 2 | 5 |
| Coal, bituminous, good ............... | 1 | 10 | | |
| Brownish-gray sand rock, exposed, about | 0 | 6 | | |
| | 5 | 11 | | |

The place of the bed appears also to be indicated by an exposure of about three inches of bituminous coal a little more than 40 feet in level below the opening on Wood's Upper Coal at Perfater's Spring already mentioned.

The quality of the Factory Cannel Bed is plainly very variable, and its thickness extremely so. The bed thins out towards the Kanawha, near Brownstown and above, and can scarcely be found there at all, having but a few inches of thickness and no cannel. It may prove workable in some spots, especially near the factory, but is so thin and variable that it can hardly be counted on. The cannel lasts so long, when exposed to the weather, that bits of it are found all along the outcrop, which is therefore comparatively easy to follow on the ground; and can be looked for between the outcrops of Wood's Upper and Wood's Lower Coal.

SHOOT COAL.—The Shoot Coal Bed, at Peytona, is so-called from the opening near the foot of the shoot at the mines. The opening was closed and no longer accessible in 1872, but was said to have had the following section from above downward:

| | FT. | IN. |
|---|---|---|
| COAL, bituminous, good, hard | 0 | 10 |
| Slate | 0 | 1½ |
| COAL, bituminous, good, very hard, "breaks almost like anthracite" | 2 | 6½ |
| | 3 | 6 |

The same bed is also said to have been opened a great many years ago, by Dr. DuBois, above the Blacksmith Bank, and found to have a thickness of over 4 feet, besides 3 inches of slate at 10 inches below the top.

The bed was opened in 1872, in Abshire's Hollow, opposite Abshire's house, with the following section from above downward:

| | FT. | IN. |
|---|---|---|
| No solid roof. | | |
| COAL, bituminous | 2 | 10 |
| COAL, "splint," or bony | 0 | 6 |
| | 3 | 4 |

The bed was likewise opened in 1872, on Indian Creek, about 300 yards above Abshire house, and 50 yards below the mouth of Meadow's Fork of Indian Creek, and had the following section from above downward:

| | FT. | IN. | FT. | IN. |
|---|---|---|---|---|
| Gray shales. | | | | |
| Soft black slate....about | 0 | 1 | | |
| COAL, bituminous | 0 | 9 | 3 | 7 |
| Slate | 0 | 3½ | | |
| COAL, bituminous | 2 | 6½ | | |
| | 3 | 8 | | |

On Lens Creek, the coal bed of Wood's lower mine (a drift some 20 feet long), on King's Branch of the Left Fork, is the same as the Peytona Shoot Coal Bed, and has the following section from above downward:

| | FT. | IN. | FT. | IN. |
|---|---|---|---|---|
| Solid sand rock exposed....about | 4 | 0 | | |
| COAL, bituminous | 1 | 0 | 3 | 8 |
| Slate or clay....about | 0 | 0½ | | |
| COAL, bituminous | 1 | 7 | | |
| Slate or clay....about | 0 | 0½ | | |
| COAL, bituminous | 1 | 0 | | |
| | 7 | 8 | | |

The same bed was opened in 1872, near the schoolhouse of the left fork of Lens Creek, and had the following section from above downward:

| | FT. | IN. | FT. | IN. |
|---|---|---|---|---|
| Brownish-gray sand rock, exposed, about | 2 | 6 | | |
| COAL, bituminous, firm and good....... | 2 | 9 | | |
| Bony coal or slate.................... | 0 | 0½ | 4 | 0½ |
| COAL, bituminous, firm and good....... | 1 | 3 | | |
| Slate, exposed..................about | 0 | 3 | | |
| | 6 | 9½ | | |

The coal seems to be of fine quality.

The same bed was formerly opened at Fry's Coal Bank, still partially accessible in 1872, and had the following section from above downward:

| | FT. | IN. |
|---|---|---|
| "Slate roof of unknown thickness." | | |
| COAL, bituminous, very firm, good.................. | 3 | 8 |
| "Slate bottom." | | |

Near the mouth of the drift the coal has a quarter-inch of slate at a foot or fifteen inches from the bottom; but the slate is said to disappear further in.

The same bed was opened rather imperfectly on Stewart's Branch, nearly three-quarters of a mile southwest of the forks of Lens Creek and had the following section from above downward:

| | FT. | IN. |
|---|---|---|
| Gray and black shales ......................about | 10 | 0 |
| Gray sand with some particles of coal mixed......... | 0 | 4 |
| COAL, bituminous.............................. | 2 | 0 |
| Hard, brownish-gray sand rock. | | |
| | 12 | 4 |

The same bed, apparently, was opened in 1872, in Peels' Hollow, with the following section from above downward:

| | FT. | IN. |
|---|---|---|
| Loam. | | |
| Brown shales...............................about | 2 | 2 |
| COAL, bituminous................................ | 0 | 6½ |
| Fireclay. | | |
| | 2 | 8½ |

But, perhaps, the coal bed was not fully exposed; or possibly, by an error of the aneroid level, this may be the representative of the Blacksmith Coal Bed.

Imperfect openings of the same bed were also made nearly opposite Nuby's, on the Left Fork of Lens Creek, where only two feet are exposed

in a crush of loose rocks; and near Asa Ferrel's, on the Right Fork of Lens Creek, where less than a foot of crop coal has been uncovered.

This coal bed is clearly the same as the bed formerly worked at the Winifrede Coal Co.'s main mine, less than a mile east of the main Parker tract. That mine was still accessible in 1872, with a little difficulty, and near the mouth of the drift gave the following section from above downward:

| | FT. | IN. | FT. | IN. |
|---|---|---|---|---|
| Brownish-gray, massive sand rock. about | 5 | 0 | | |
| Slate | 0 | 8 | | |
| Brownish-gray, massive sand rock | 1 | 9 | | |
| Slate | 3 | 0 | | |
| COAL, bituminous, firm and good | 2 | 9 | | |
| Clay | 0 | 3 | 4 | 6 |
| COAL, bituminous, firm and good | 1 | 6 | | |
| Shale, exposed about | 1 | 0 | | |
| | 15 | 11 | | |

The quality of the coal, as well as the slate or clay parting, is extremely like what is found at the opening on Wood's Lower Bed (the Peytona Shoot Bed), near the schoolhouse of the Left Fork of Lens Creek, and at Fry's Coal Bank on Ketcham Branch and at other points. The identity was evidently recognized by Prof. Hall forty years ago.

The coal of Wood's Lower Bed on Lens Creek seems all to be of very fine quality, richer in gas than Wood's Upper Coal and somewhat less firm than that, though still very firm and capable of bearing handling very well. It is much liked as a domestic coal, and would probably be a good gas coal. It is unquestionably the same as the one of the Winifrede mines, the coal of which bears a very high reputation; and is probably the same in quality, since those mines are within a mile of the eastern edge of the main Parker tract. Besides, as already pointed out, the resemblance is very strong indeed.

The Winifrede Coal was supposed in 1872 to be also the same as the bed of the Coalburg mines, a couple of miles more distant up the Kanawha; but, in spite of the resemblance of the structure of the two beds and the quality of the coals and other arguments, Prof. White (Bulletin 65, p. 162), says that the Winifrede is seventy-five or one hundred feet lower than the Coalburg coal, reckoning from the Kanawha black flint. In that case it would seem that the Coalburg bed must be the same as Wood's Upper Coal, the Upper cannel of Peytona; but the distance apart in these two surveys is about one hundred and twenty feet, a difference hard to reconcile. The Shoot Bed of Peytona, Wood's Lower Bed of Lens Creek, seems hereabouts to be the most uniform in thickness and in quality of all the coals below the barren measures, and to be everywhere a very excellent, firm, bituminous coal and of workable thickness wherever it has been fully opened. Towards the Kanawha,

outside of the tracts, it appears to be in two or three benches separated by layers of clay a foot or even more in thickness.

BLACKSMITH COAL.—The Blacksmith Coal at Peytona is so named for its purity and usefulness in the forge, and would seem to be very persistently of fine quality, since the same bed is called so in the northern edge of the State. It is, however, probably too thin to work at present, except for local use along the outcrop.

It was worked by a drift at the lower part of the Peytona mines, and had there the following section from above downward :

| | | FT. | IN. | FT. | IN. |
|---|---|---|---|---|---|
| Brownish-gray sand rock | about | 4 | 0 | | |
| Hidden | " | 1 | 6 | | |
| Brownish-gray, hard shales, exposed | " | 0 | 6 | | |
| Soft shales | " | 0 | 2 | | |
| COAL, bituminous | " | 0 | 2 | | |
| Bony coal or slate | " | 0 | 1¼ | | |
| COAL, bituminous | " | 0 | 9 | 2 | 3 |
| Slate | " | 0 | 0¼ | | |
| COAL, bituminous | " | 1 | 2½ | | |
| Clay, apparently. | | | | | |
| | | 8 | 5 | | |

The bed was opened also at Abshire's Coal Bank, on Indian Creek near Abshire's Hollow, with the following section from above downward :

| | | FT. | IN. |
|---|---|---|---|
| Shaly sand rock, exposed | about | 5 | 0 |
| COAL, bituminous, good | | 2 | 0 |
| Fireclay, mixed with slate. | | | |
| | | 7 | 0 |

The same bed is opened, too. in Abshire's Hollow, back of his house, with the following section from above downward :

| | | FT. | IN. |
|---|---|---|---|
| Shales, exposed | about | 3 | 0 |
| Shaly sand rock | " | 2 | 0 |
| Slate | " | 0 | 6 |
| COAL, bituminous | " | 2 | 1 |
| Fireclay mixed with slate. | | | |
| | | 7 | 7 |

This bed at Lens Creek appears at about twenty feet below Wood's Lower Coal.

It would seem to be the bed opened in 1872 on Ketcham Branch, near the southeast corner of the map, in two places near together on opposite

sides of the branch and about half a mile from its mouth. At the upper, southern, one there was the following section from above downward:

| | | FT. | IN. |
|---|---|---|---|
| Gray shale, exposed | about | 3 | 0 |
| Black slate | " | 1 | 6½ |
| Gray shales | " | 0 | 8½ |
| COAL, bituminous, and clay and slate in several layers, mostly coal | " | 1 | 2 |
| Gray shales. | | | |
| | | 6 | 5 |

At the lower, northern, opening of the two, there was the following section from above downward:

| | | FT. | IN. | FT. | IN. |
|---|---|---|---|---|---|
| Brownish-gray sand rock | about | 1 | 6 | | |
| Brown and gray shales | " | 5 | 0 | | |
| Black slate | " | 1 | 5 | | |
| Gray shales | | 1 | 0 | | |
| COAL, bituminous | | 0 | 3 | | |
| Clay | | 0 | 2 | 0 | 7 |
| COAL, bituminous | | 0 | 2 | | |
| | | 9 | 6 | | |

The same bed seems also to have been opened on the Stewart Branch of the Left Fork, some 500 yards above the mouth of the branch, by a couple of old ruined drifts that expose a few inches only of the top of the coal, with two or three feet of shales over it.

JERROLD'S COAL.—Jerrold's Coal of Lens Creek seems not to exist at Peytona, but to be represented perhaps by some three inches of black slate at the bottom of about twenty feet of apparently iron-bearing brown shales just like those that overlie the bed on Lens Creek. The black slate is exposed on the railroad about sixteen feet above the top of the lower shoot.

The bituminous coal bed worked by Jerrold on the bank of the Left Fork of Lens Creek, just below the mouth of Ketcham Branch, has the following section there, from above downward:

| | FT. | IN. | FT. | IN. |
|---|---|---|---|---|
| Loose blocks of sandrock. | | | | |
| Roof slate, exposed | 1 | 0 | | |
| COAL, bituminous, comparatively soft | 0 | 7 | | |
| COAL, bituminous, much of it hard "splint," but generally less hard than Wood's Upper Coal | 2 | 8½ | 3 | 3½ |
| | 4 | 3½ | | |

It would seem probable on the whole that it is the same bed that was worked at Mitchel's Coal drifts on the left fork of Lens Creek about 200 yards above the mouth of Ketcham's Branch; though it is possible that

the coal here is a local thickening of the small bed that occurs some fifteen feet below Jerrold's Coal. The section at Mitchel's drifts is as follows, from above downward:

| | FT. | IN. |
|---|---|---|
| Slate, exposed................................about | 1 | 6 |
| COAL, bituminous, less firm than Wood's Upper Coal, but of fair quality................................ | 3 | 1 |
| "Slate floor." | | |
| | 4 | 7 |

The same bed apparently was opened at the old drift on the Ketcham Branch of the Left Fork of Lens Creek, near the mouth of the branch. The coal is partly covered at the bottom; but would seem to measure about two feet in thickness.

The Jerrold Coal is seen also at Mrs. Nuby's coal mine, a drift about six feet long on the Left Fork of Lens Creek, 300 yards below her house, with the following section from above downward:

| | FT. | IN. | FT. | IN. |
|---|---|---|---|---|
| Shales, exposed...................about | 4 | 0 | | |
| COAL, bituminous, of fair quality........ | 1 | 0 | | |
| Clay.................................. | 0 | 0¼ | 2 | 10¾ |
| COAL, bituminous, of fair quality....... | 1 | 10½ | | |
| | 6 | 10¾ | | |

Two inches above the clay seam, there is, at least in places, another similar clay seam.

The same bed was worked with eight old drifts close together just across the creek, and had there the following section from above downward:

| | FT. | IN. |
|---|---|---|
| Sand rock, massive. | | |
| Slaty shales and shaly sand rock with small iron-ore nodules..................................about | 15 | 0 |
| COAL, bituminous, with two or three quarter-inch seams of black clay at about nine inches below the top; apparently 3,, 0 or more in one drift, in another, measured.............................. | 2 | 10 |
| Slaty shales.................................... | 10 | 0 |
| | 25 | 0 |

The same bed is worked with a drift a dozen yards long at Myer's Coal Bank, close by the oil factory already mentioned, and has the following section from above downward:

| | FT. | IN. | FT. | IN. |
|---|---|---|---|---|
| Brownish-gray sand rock, massive, about | 12 | 0 | | |
| Slate................................ | 0 | 6 | | |
| COAL, bituminous, good................ | 0 | 9 | | |
| Black clay............................ | 0 | 0½ | 2 | 8½ |
| COAL, bituminous, good................ | 1 | 11 | | |
| | 15 | 2½ | | |

The same bed is also worked by Gus. Hoffman, on the Vinnie Lick Branch of the Right Fork of Lens Creek, and has there the following section from above downward :

| | FT. | IN. |
|---|---|---|
| COAL, bituminous | 0 | 6 |
| Clay | 0 | 0⅛ |
| COAL, bituminous | 3 | 0 |
| | 3 | 6⅛ |

The bed has been worked, too, by a drift on the opposite (west) side of the Right Fork of Lens Creek, back of Gus. Hoffman's house, and has there the following section from above downward :

| | FT. | IN. |
|---|---|---|
| Brownish-gray shaly sand rock ... about | 8 | 0 |
| Shales with iron nodules | 1 | 6 |
| COAL, bituminous | 2 | 1 |
| | 11 | 7 |

The bed was imperfectly opened on the Right Fork of Lens Creek, opposite the mouth of Orchard Hollow and a quarter of a mile above the mouth of Vinnie Lick Branch, and had the following section from above downward :

| | FT. | IN. |
|---|---|---|
| Shaly sand rock with some nodules of impure iron ore ... about | 6 | 0 |
| COAL, bituminous, good, but much weathered, at least ... about | 1 | 9½ |
| Dark shales | 5 | 0 |
| | 12 | 9½ |

Half a foot of the top of the coal bed is exposed under the shales near Mr. Hoffman's, opposite the mouth of Big Hollow, on the Right Fork of Lens Creek.

The bed was opened in 1872 in Locust Hollow near the east bank of the Right Fork of Lens Creek, and had the following section from above downward :

| | FT. | IN. | FT. | IN. |
|---|---|---|---|---|
| Clay shales, no solid roof | 2 | 0 | | |
| COAL, bituminous, mostly hard and good. | 1 | 6¼ | } 3 | 0¼ |
| Clay | 1 | 0 | | |
| COAL, bony | 0 | 6 | | |
| | 5 | 0¼ | | |

Another imperfect trial pit on the same bed, some twenty yards to the south, gave about the same measurements, but some of the lower bench seemed to be like cannel.

The same bed is at least partially exposed where it finally passes southward beneath the bottom of the valley of the Right Fork of Lens Creek, at the mouth of Rise Hollow. The coal there is partially concealed by muddy water and perhaps rubbish in the hole, but would seem to be only 1,, 6 or two feet thick, with only two feet of wash for a cover. The wash is stripped off, and the coal dug out. The coal is firm and in large lumps, bituminous, of good quality and much liked by the country people.

The coal at Jerrold's, Hoffman's, Nuby's and Myer's mines, and at Rise Hollow is of good quality, but not equal to Wood's Upper and Lower coals. It is less firm, especially the upper six inches, than either of them; but the greater part of the bed is far from being tender. The quality in fact seems to be on the whole pretty fair. The thickness would seem to be rather variable, and it may prove to be unworkable at present in some parts of the tracts. It not only disappears at Peytona, but on the Kanawha above Brownstown would seem to be hardly of workable thickness, or only two feet and a half, though worked a little at some points.

VICKER'S COAL.—Opposite the mouth of Vicker's Branch, on the Left Fork of Lens Creek, at the lower end of the eight drifts on the Jerrold Coal, there are two old drifts on a coal, a dozen or fifteen feet lower; and, for want of a more suitable name, it may be called Vicker's Coal. The coal is no longer exposed for measurement here; but seems to have been perhaps two feet thick.

The same bed was worked at an old drift about fifteen feet below Jerrold's old coal opening on the Left Fork of Lens Creek, two hundred and fifty yards below the mouth of Ketcham Branch. There also the drift has fallen in so as to be inaccessible and leave the coal unexposed. The thickness seemed to have been perhaps two feet.

The bed may probably be the same as the one exposed at Peytona, nine feet below the top of the waterfall below the lower shoot. It has there the following section from the top of the waterfall downward:

| | FT. | IN. |
|---|---|---|
| Brownish-gray sand rock, very cross-bedded......... | 9 | 0 |
| COAL, bituminous.................................. | 0 | 3 |
| Brownish-gray sand rock (?) | | |
| | 9 | 3 |

It is probable that the coal bed was of greater thickness than that, at the drifts on Lens Creek, or it would not have been opened for working at all; but as it seems to have been little worked compared with the Jerrold Coal just above it, there is no probability that it was more than the two feet thick it seems to have been.

It is barely possible that the coal of Mitchel's old drifts on Lens Creek just above the mouth of Ketcham Branch may be the Vicker's bed; and it was so supposed probable in 1873; but in that case it would have

been only quite locally thicker there. It seems on the whole very much more likely that Mitchel's coal was the same as Jerrold's.

### Comparison with the Northern West Virginia Section.

According to Prof. J. J. Stevenson (*Trans. Am. Phil. Soc.*, Vol. xv, pp. 17–31, 1872), the section of the carboniferous rocks of a portion of Monongalia and Marion counties, in the northern edge of West Virginia, near the southwest corner of Pennsylvania, is as follows, from above downward:

UPPER COAL GROUP—MONONGAHELA RIVER SERIES.

| | | Mean. | | | |
|---|---|---|---|---|---|
| | Ft. | Ft. | In. | Ft. | In. |
| 1. Sandstone, "Waynesburg" | 30–40 | 35 | 0 | 43 | 0 |
| 2. Shale | 1–15 | 8 | 0 | | |
| 3. Coal, "Waynesburg" | 6–9 | 7 | 6 | | |
| 4. Sandstone | 15 | 15 | 0 | | |
| 5. Shale | 8 | 8 | 0 | | |
| 6. Limestone | 5 | 5 | 0 | | |
| 7. Shales and sandstone | 20 | 20 | 0 | | |
| 8. Limestone and shale | 30 | 30 | 0 | | |
| 9. Sandstone and shale | 35 | 35 | 0 | | |
| 10. Limestone | 6 | 6 | 0 | 194 | 6 |
| 11. Sandstone | 15 | 15 | 0 | | |
| 12. Limestone | 7 | 7 | 0 | | |
| 13. Sandstone | 10 | 10 | 0 | | |
| 14. Limestone | 8 | 8 | 0 | | |
| 15. Sandstone and shales | 23 | 23 | 0 | | |
| 16. Shale | 1–25 | 12 | 6 | | |
| 17. Coal, "Sewickley" | 4½–6 | 5 | 3 | 5 | 3 |
| 18. Shale | 5–8 | 6 | 6 | | |
| 19. Limestone | 9 | 9 | 0 | 44 | 6 |
| 20. Sandstone | 4–10 | 7 | 0 | | |
| 21. Limestone | 22 | 22 | 0 | | |
| 22. Coal, "Redstone" | 4–5 | 4 | 6 | | |
| 23. Fireclay | 1 | 1 | 0 | | |
| 24. Limestone | 12 | 12 | 0 | 39 | 0 |
| 25. Shale | 5–12 | 8 | 6 | | |
| 26. Sandstone | 0–35 | 17 | 6 | | |
| 27. Coal, "Pittsburgh" | 7–14 | 10 | 6 | 10 | 6 |
| 28. Fireclay | 3 | 3 | 0 | | |
| LOWER BARREN GROUP—BARREN MEASURES. | | | | 20 | 0 |
| 1. Shale with iron | 14 | 14 | 0 | | |
| 2. Limestone | 2–4 | 3 | 0 | | |
| 3. Coal | 1½–2 | 1 | 9 | 1 | 9 |

| | | Mean. | | | |
|---|---|---|---|---|---|
| | Ft. | Ft. | In. | Ft. | In. |
| 4. Shale | 3 | 3 | 0 | | |
| 5. Sandstone | 25 | 25 | 0 | | |
| 6. Shales | 8 | 8 | 0 | | |
| 7. Limestone | 3 | 3 | 0 | | |
| 8. Shale with iron | 4½ | 4 | 6 | 86 | 6 |
| 9. Limestone | 1½ | 1 | 6 | | |
| 10. Shales and shaly limestone | 22 | 22 | 0 | | |
| 11. Limestone | 1½ | 1 | 6 | | |
| 12. Shale | 18 | 18 | 0 | | |
| 13. Coal | 1¼–2 | 1 | 7½ | 1 | 7½ |
| 14. Sandstone | 10–35 | 17 | 6 | 17 | 6 |
| 15. Coal | ⅝–1¼ | 0 | 11½ | 0 | 11½ |
| 16. Limestone | 8 | 8 | 0 | | |
| 17. Shales, olive | 10 | 10 | 0 | | |
| 18. Limestone | 3 | 3 | 0 | | |
| 19. Shales, olive | 12 | 12 | 0 | 91 | 0 |
| 20. Sandstone | 40 | 40 | 0 | | |
| 21. Conglomerate | 0–6 | 3 | 0 | | |
| 22. Sandstone | 15 | 15 | 0 | | |
| 23. Coal | 3½–4 | 3 | 9 | 3 | 9 |
| 24. Shales, variegated, with some shaly sandstone | 33½ | 33 | 6 | | |
| 25. Sandstone | 1–4 | 2 | 6 | | |
| 26. Shale, calcareous and fossiliferous | 2–4 | 3 | 0 | 63 | 0 |
| 27. Shale, variegated, fossiliferous | 24 | 24 | 0 | | |
| 28. Coal | ⅓–1½ | 0 | 11 | 0 | 11 |
| 29. Limestone | 5 | 5 | 0 | | |
| 30. Shales, variegated, with iron | 20 | 20 | 0 | | |
| 31. Sandstone | 10–20 | 15 | 0 | | |
| 32. Shales with iron | 10–15 | 12 | 6 | 139 | 6 |
| **Lower Group—Allegheny River Series.** | | | | | |
| 1. Sandstone, "Mahoning" | 75 | 75 | 0 | | |
| 2. Shales | 12 | 12 | 0 | | |
| 3. Coal | 1⅓ | 1 | 4 | 1 | 4 |
| 4. Shales | 1–25 | 13 | 0 | 13 | 0 |
| 5. Coal | 4–5 | 4 | 6 | 4 | 6 |
| 6. Shales | 10 | 10 | 0 | 10 | 0 |
| 7. Coal | 1 | 1 | 0 | 1 | 0 |
| 8. Sandstone | 5 | 5 | 0 | | |
| 9. Shale | 10 | 10 | 0 | 49 | 6 |
| 10. Limestone, "ferriferous" | 4–5 | 4 | 6 | | |
| 11. Shale | 30 | 30 | 0 | | |

Lyman.

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Jerome, Luther, Desvoeux and Herder have each suggested some such colloquy as I have proposed, their exact views were unknown to me until this article was in print; and I would submit that Herder's very similar division in many instances is an argument in favor of the hypothesis.

## ECCLESIASTES.

1 The words of the Ecclesiast the son of David (the) king of Israel in Jerusalem.*

SOLOMON.

2 Perplexity of perplexities, said the Ecclesiast, all is perplexity.†
3 What profit to the man in all his labor
In which he labors under the sun?

EGYPTIAN.

4 A generation goes, and a generation comes,
And the earth has stood for ever.
5 The sun rises and the sun sets:
And hastes to its place (again).
6 It rising there moves toward the South:
And circles (again) toward the North.
The wind goes in a circling of circles:
And returns upon its circles.
7 All the streams run into the sea,
And the sea is not filled:
To the place where the streams run,
Thither they return to flow.
8 All words are feeble:
A man shall not be able to speak it:
And the eye shall not be filled with seeing:
And the ear shall not be satisfied with hearing.
9 What has been? that is what shall be:
And what has been done? that shall be done.
And there is no new thing under the sun.
10 Who shall speak and say, Behold this is new
It hath already happened in the ages before us.
11 There is no remembrance of the first things,
And to the latest things there shall be no remembrance
Among those that shall be born at the last.

SOLOMON.

12 I the Ecclesiast became King
Over Israel in Jerusalem:

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*Translated from the Septuagint.
†See Liddell & Scott for true rendering of ματαιοτης.

| | Stevenson, N. Edge, W. Va. Ft. | In. | Peytona, General. Ft. | In. | Lens Cr., General. Ft. | In. | Near Ferrel's R. F., Lens Cr. Ft. | In. | Near Mouth of Ketcham Br. Ft. | In. | Near Nuby's L. F., Lens Cr. Ft. | In. | N. E. Cor. Map & Church Hol. Ft. | In. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coal bed, "Pittsburgh"..... | 10 | 6 | 4 | 0 | 5 | 0 | | | | | 5 | 6 | 4 | 9 |
| Interval..................... | 20 | 0 | 23 | 0 | | | | | | | | | | |
| Coal bed..................... | 1 | 9 | 0 | 6 | 89 | 0 | | | | | 89 | 0 | 57 | 0 |
| Interval..................... | 86 | 6 | 85 | 0 | | | | | | | | | | |
| Coal bed, "Slate Vein"..... | 1 | 7½ | 0 | 4 | 3 | 0 | | | | | 3 | 3 | 3 | 0 |
| Interval..................... | 109 | 5½ | 90 | 0 | | | | | | | | | | |
| Coal bed, "No. 23"......... | 3 | 9 | 0 | 3 | | | | | | | | | | |
| Interval..................... | | | 55 | 0 | | | | | | | | | | |
| Coal bed..................... | | | 5 | 0 | 300 | 0 | | | | | 303 | 0 | 300 | 0 |
| Interval..................... | 203 | 5 | 120 | 0 | | | | | | | | | | |
| Coal.......................... | | | 0 | 6 | | | | | | | | | | |
| Interval bed................. | | | 16 | 4 | | | | | | | | | | |
| Coal, "Upper Cannel"...... | 1 | 4 | 2 | 6 | 3 | 0 | 2 | 6 | 3 | 4 | 3 | 6 | 1 | 3 |
| Interval..................... | 12 | 6 | 18 | 3 | 44 | 0 | 26 | 9 | 61 | 0 | 47 | 0 | 50 | 0 |
| Coal bed, "Main Cannel"... | 4 | 6 | 2 | 10 | 3 | 0 | 2 | 6 | 0 | 9 | 3 | 0 | 0 | 6? |
| Interval..................... | 10 | 0 | | | | | | | | | | | | |
| Coal bed, "No. 7".......... | 1 | 0 | 92 | 6 | 67 | 0 | 68 | 0 | 63 | 0 | 66 | 0 | | |
| Interval..................... | 49 | 6 | | | | | | | | | | | | |
| Coal bed, "Shoot Bed"..... | 3 | 6 | 3 | 6 | 3 | 8 | 0 | 6 | 4 | 0 | 2 | 0+ | | |
| Interval..................... | 25 | 0 | 23 | 0 | 22 | 0 | | | | | 23 | 0 | | |
| Coal bed, "Blacksmith".... | 3 | 6 | 2 | 0 | 0 | 4 | 78 | 0 | 93 | 4 | 0 | 3 | | |
| Interval..................... | 70 | 0 | 63 | 0 | 64 | 0 | | | | | 66 | 0 | | |
| Coal, "Jerrold's".......... | 1 | 9 | (slate) | | 3 | 0 | 2 | 0? | 3 | 4 | 3 | 0 | | |
| Interval..................... | 4 | 0 | 37 | 0 | 14 | 0 | | | 14 | 0 | 14 | 0 | | |
| Coal, "Vicker's"........... | 1 | 0 | 0 | 3 | 2 | 0? | | | 2 | 0? | 2 | 0? | | |
| | 623 | 7 | 644 | 9 | 602 | 0 | 180 | 3 | 244 | 9 | 630 | 6 | 416 | 6 |

*The Ethics of Solomon.*

*By J. Cheston Morris, M.D.*

(*Read before the American Philosophical Society, October 5, 1894.*)

Probably at no period of human history, unless it be in our own time and case, do we read of such changes as came over the Hebrew nation in the course of the century covering the reigns of Saul, David and Solomon.

For three or four centuries preceding, the land of Palestine had been occupied by the twelve tribes who took possession of it under the leadership of Joshua, the successor in command of Moses the great lawgiver. Trained in Egyptian knowledge and civilization, we should naturally look for marks of the impress of Egyptian modes of thought and expression in their writings; and accordingly we do find much that is to be explained by their contact with, and departure from, this phase of human development as illustrated by the monuments and mummies which have been and are now so carefully studied. A pastoral and agricultural people, living in detached communities, associated more or less closely by consanguinity and common dangers, and with a worship which separated them from the idolatrous nations surrounding them, they seem to have enjoyed varying degrees of prosperity and freedom under the judges or rulers who arose among them from time to time. The ancient empire of the Hittites had crumbled and disappeared ; the rival Assyrian and Egyptian empires had alternately prospered and waned, and were then, as they continued to be, in frequent contact and struggle for supremacy. Along the east coast of the Mediterranean were powerful cities of Philistines and the commerce-loving Tyrians and Sidonians. As in after ages, the rich and fertile plains, the valleys and mountain fastnesses of the land of Canaan, Gilead, Bashan and Moab produced food and cattle in enormous quantities for the supply of these neighboring nations, and caravan routes were well established along the coast and across the Arabian and Syrian deserts. By these communication was made and exchange effected between the products of the valleys of the Nile and the Euphrates ; while by the commerce of Tyre, the Iberian peninsula and possibly the shores of Albion were brought into intercourse with far Cathay, as we may infer from the length attributed to the voyages of the navies of Hiram and Solomon and the cargoes with which they were freighted. But with the movements or interests of their neighbors the Hebrews hitherto had had little concern—they might hardly even have had more title to be considered as a nation than have to-day the wandering Bedouin bands that are the sole permanent inhabitants of Arabia. Their territory was raided by Moabite, Amalekite or Philistine : no advance in arts or sciences took place among them ; and even their monotheistic faith seemed likely to die out, as it degenerated into a superstitious reverence for the Ark, or was overlaid with the idolatry of the surrounding peoples. After the capture of their great Palladium

by the Philistines, they became the slaves of the latter, until, under the guidance of Samuel, Saul raised the standard of revolt, blew the trumpet in Gibeah with the shout, "Let the Hebrews hear." Successful in driving off the oppressing bands of the Ammonites, he was soon surrounded by large numbers of his countrymen now roused to strike for their liberty; he organized them and led them to victory. But the crowning achievement of the war with the Philistines which ensued was not his, but that of "a youth, ruddy and of fair countenance," who with sling and stone slew in mortal combat the challenging giant of the Philistine army, and thus became, in accordance with Saul's offer, his son-in-law. The kingdom of the Hebrews was then successfully established, and by the prowess of its warriors gained respectful consideration among its neighbors. The subsequent madness of Saul, his jealousy and banishment of David, and his death in his last great battle with the Philistines, we need not stop to consider, except to note the indignation which Nabal's sneer, "There be many *slaves* nowadays who have run away from their masters," aroused in David, as an index of how the movement of the Hebrews was regarded by the wealthy sheep-master of Carmel. The death of Saul was in a few years followed by David's public recognition as king of the united nation—by the capture of Jerusalem from the Jebusites and its establishment as his capital, whence he waged war after war against the surrounding Moabites, Edomites and Ammonites, extending his territories, carrying off immense booty, and levying heavy imposts on his subjugated enemies. Of all this we read only incidental and fragmentary allusions, yet sufficient to enable us to trace the rise of the nation to power and wealth; so that we are not surprised at the alliance of Pharaoh's daughter with his son Solomon. If David's character as that not only of the sweet singer of Israel, but a large-hearted, earnest man and devoted servant of God, should interest us, not the less should that of his son and successor. Born and reared amid all these commotions and developments, and doubtless trained carefully by Nathan and the other counsellors of his father, and impressed with the duty laid upon him to consolidate and strengthen the new kingdom, he evinces a spirit of wisdom and discretion, an earnest study of the conditions of his life work that may well win our admiration. The building of the temple and the palace for which preparations had been made during his boyhood would naturally draw to Jerusalem the best skill and thought of the time; for it was well known that neither means nor desire were wanting to make them what indeed they were, worthy of rank among the wonders of the world. Then also the overland commerce between Egypt and Assyria traversing such an extent of Solomon's dominions, and fostered by him by building fortresses and outposts to protect the caravans as they came from Damascus to the shores of the Mediterranean, would bring such an amount of business to Jerusalem that we can readily understand how he made silver and gold as common as iron and stone in his rapidly growing capital. Judicious alliances and treaties, his reputation for justice and fairness, and the prosperity of the

nation, naturally attracted men of science and thought around him, just as in later days they were to be found at the court of Haroun al Raschid. Then the public works, undertaken and carried out so magnificently with the aid of skilled men from Tyre, for instance, would have brought together the architects and mechanicians, the sculptors and brassfounders, and many other artisans whose occupations and achievements must have seemed most marvelous to the nation of shepherds and herdsmen. We read in the sacred history of the brassfoundings and castings made by some of these men, and can readily comprehend after clouds of smoke from the furnaces had filled the valley and plain of the Jordan, and forms of beauty and grace came from the moulds prepared by these foreigners, how tales of genii and afreets spread among the people, and Solomon's ring became invested with the magical powers which it possessed in the imaginations of the East. We can see the genesis of stories like that of Aladdin. But amid all this concourse of men of thought and action the guiding spirit is that of Solomon. Of studious, reflective, observant and judicial turn of mind, we find recorded among his works not only proverbs and poems, but treatises on natural history. We are informed that he "spake of trees from the hyssop to the cedar of Lebanon," *i. e.*, from mosses to conifers, "and of beasts and fowl, creeping things and fishes." Though these treatises are lost, we may judge of his accuracy from such allusions as are made in Proverbs and Solomon's Song to the habits and actions of both animals and men.

We may then easily picture to ourselves this powerful king gathering around him a sort of Academy of Sciences, or Royal Philosophical Society, before which would come many and varied subjects of interested discussion among representative men of the differing civilizations of the period. Before such an "Assembly" or εκκλησια, or acting perhaps as its Secretary or Reporter or Clerk, εκκλησιαστης, we may imagine him reading a paper on the theme of man: his object and destiny in the universe, and how he can attain to his best development, his highest good. We may suppose Egyptian Materialism, Assyrian Fatalism, and Tyrian Commercialism or Opportunism well represented in the audience, either taking part in the discussion or having their respective views stated, to be criticised and shown to be partly erroneous or insufficient, and followed by the statement of his own solution, and the application of it to the whole problem. This is to be found in Ch. viii. 1: "Wisdom maketh a man's face to shine." If we look to Solomon's conception and impersonification of Wisdom as given in Proverbs viii and ix, and think of the contrast he draws between it and "the false woman" as Socrates ages after did between the true and false reason, and recall the devotion of the Alexandrian school to the Holy Wisdom which led to the opening words of John's Gospel in which the same wisdom is called The Word—Λογος—the Son of God, and afterwards to the erection of "Hagia Sophia" at Constantinople, we shall, it seems to me, gain the clue so much sought after to this Book of Ecclesiastes. It then all comes into logical form as a grand discussion on the theme of what

is profitable for man, and what should be the ruling aim of his life; and the conclusion is given in the last verses.

The propositions which Solomon maintains are:

The omnipotence of God:

The future life of man: and

The judgment after death.

The whole is cast into the form of a poem, as may easily be seen by putting the verses of the Authorized Version in parallelism, or by following the Septuagint translation, in which I find this already done. I have also tried to analyze the differing arguments and sentiments, and to attribute them respectively to an Egyptian, an Assyrian, and a Tyrian speaker, and to Solomon in reply, concluding with the verdict of the Assembly as given by its "Shepherd" or presiding officer.

As to the success of such an effort and how far it explains the whole book, I leave to the candid reader and critic to determine. The "materialistic" views of esoteric Egyptian philosophy, the successive passage of earth, air, fire and water into each other, the perpetual round of the forces of Nature, are first given; then the dark "fatalism" of the East, "to everything there is a season;" then selfish "opportunism," are successively discussed, and dismissed as insufficient or unworthy explanations of this "sore travail of the sons of men." Then comes the solution, to walk in the fear of God, in the wisdom of God, in the hope of a life beyond, followed by the beautiful peroration, and summing up of the whole.

The composition of the book is easily explained by the circumstances given, and its argument is complete, without any necessity for supposing later Epicurean or Stoic or Platonic influences. The problems of human existence had been thought out far beyond these in the East long before, as we find from Pythagoras, and the monumental evidences we are discovering in the present era of investigation among the remains of antiquity.

Brugsch Bey, in 1876, drew for me a schema which represented what he considered the esoteric Egyptian philosophy: four altars in profile, dedicated to earth, fire, air and water respectively, while a circle above indicated the perpetual change of matter from one of these forms into another. Each is worshiped as divine, and each has both a male and a female name. From this I took my concept of the views of the Egyptian. Omar Kayam's celebrated "Rubayat" furnished me with that of the Assyrian, while the Chinese commissioner, Hon. Fung Kwang Yu, in his statement before the Parliament of Religions, at Chicago, of the doctrines and modes of worship of the followers of Confucius almost exactly echoes the sentiments of my Tyrian.

Since writing the above I have availed myself of the kind criticisms and suggestions as to several passages of my friends: Rt. Rev. O. W. Whitaker, Dean Bartlett, Dr. McVickar, Prof. Morris Jastrow, Jr., Dr. W. F. Brand and Dr. Benjamin Lee; to whom, as well as to Rev. Mr. Elwyn and Rev. Dr. Cattell, I hereby return my thanks and acknowledgments. While

Jerome, Luther, Desvoeux and Herder have each suggested some such colloquy as I have proposed, their exact views were unknown to me until this article was in print; and I would submit that Herder's very similar division in many instances is an argument in favor of the hypothesis.

## ECCLESIASTES.

1 The words of the Ecclesiast the son of David (the) king of Israel in Jerusalem.*

SOLOMON.

2 Perplexity of perplexities, said the Ecclesiast, all is perplexity.†
3 What profit to the man in all his labor
In which he labors under the sun?

EGYPTIAN.

4 A generation goes, and a generation comes,
And the earth has stood for ever.
5 The sun rises and the sun sets:
And hastes to its place (again).
6 It rising there moves toward the South:
And circles (again) toward the North.
The wind goes in a circling of circles:
And returns upon its circles.
7 All the streams run into the sea,
And the sea is not filled:
To the place where the streams run,
Thither they return to flow.
8 All words are feeble:
A man shall not be able to speak it:
And the eye shall not be filled with seeing:
And the ear shall not be satisfied with hearing.
9 What has been? that is what shall be:
And what has been done? that shall be done.
And there is no new thing under the sun.
10 Who shall speak and say, Behold this is new
It hath already happened in the ages before us.
11 There is no remembrance of the first things,
And to the latest things there shall be no remembrance
Among those that shall be born at the last.

SOLOMON.

12 I the Ecclesiast became King
Over Israel in Jerusalem:

*Translated from the Septuagint.
†See Liddell & Scott for true rendering of ματαιοτης.

13 And I gave my heart to seek out
And to observe in wisdom
Concerning all things happening under heaven:
For a difficult task God has given to the sons of men,
That they should be exercised in it.
14 I saw all the deeds done under the sun:
And behold all is perplexity and grasping of wind.
15 The scattered cannot be arranged in order,
And that which is lacking cannot be numbered.
16 I spoke in my heart to say:
Behold I am increased, and have added wisdom
Above all who were before me in Jerusalem.
And I gave my heart to know wisdom and knowledge:
17 And my heart considered many things,
Wisdom and knowledge, parables and understanding.
I knew that even this is a grasping of wind;
18 For in abundance of *wisdom* is an abundance of knowledge ·
And the one adding knowledge adds pain.
2 I said in my heart, Come, I will prove thee in pleasure,
And see into the good: and lo even this too is perplexity.
2 I said to laughter, It is excess;
And to pleasure, Why doest thou this?
3 And I observed whether my heart would heat my flesh as wine:
And my heart walked in wisdom
And to seize upon pleasure;
That I might see what is good for the sons of men,
What they should do under the sun
All the days of their life.
4 I increased my working:
I builded me houses: I planted me vineyards:
5 I made for myself gardens and parks
And I planted in them every tree of fruit.
6 I made for me fountains of waters
To water thence the forest producing the trees.
7 I bought me men slaves and women slaves,
And house servants were born to me:
And even the possession of herd and flock was great,
Beyond all that had been before me in Jerusalem.
8 I gathered me even silver and gold,
And the treasures of Kings and of the countries.
I made for myself songsters and songstresses,
And luxuries of sons of men, cupbearer and female cupbearers.
9 And I was increased, and added
Beyond all who were before me in Jerusalem:
And indeed my wisdom remained with me.
10 And all which my eyes desired I withheld not from them:

I refused not my heart any pleasure,
Because my heart rejoiced in all my labor :
And this was my portion from all my labor.
11 And I beheld all the works which my hands had wrought,
And on the labor I had labored to do,
And behold all was perplexity, and grasping of wind
And there is no profit under the sun.
12 And I looked to consider wisdom,
And excess and folly :
For what man shall follow (*i. e.*, excel) after this plan?
Such he (the King) hath done (already).
13 And I saw that wisdom excels folly
As light excels darkness.
14 The eyes of the wise are in his head :
And the fool walks in darkness :
And I know, even I,
That one end shall meet them all.
15 And I said in my heart,
As the ending of the fool
Shall there be an ending even to me :
And wherefore was I wise?
I spoke moreover in my heart
That even this is perplexity,
Because the fool speaks from excess,
16 That there is no memory of the wise
Any more than of the fool through Eternity,
Because in the coming days all shall be forgotten.
And how dies the wise man as the fool?
17 And I hated life :
For it was evil to me,
The work done under the sun :
For all is perplexity, and grasping of wind.
18 And I hated all my labor
In which I labor under the sun.
19 For I shall leave it to the man who comes after me :
And who knows whether he shall be wise or a fool?
And whether he shall have authority in all my labor
In which I have labored and been wise under the sun?
This indeed is perplexity.
20 Then I turned to detach my heart
From all my labor which I had labored under the sun.
21 For there is a man, whose labor is in wisdom
And in knowledge and in manliness :
And the man shall give his portion to one who did not labor in it!
This is indeed perplexity and great injustice,
That it happens thus to the man
In all his labor and the grasping of his heart.

22 What shall be to the man in all his labor
And in the grasping of his heart
In which he labors under the sun?
23 For all his days are a struggling
Of pains and of his rage,
And even in the night his heart sleeps not—
This indeed is perplexity.

EGYPTIAN.

24 There is no good for man (except)
What he eats and what he drinks,
And what good he shows his soul in his labor.

SOLOMON.

Even this I see is from the hand of God.
25 For who eats and drinks without Him?
26 For to the good man before His Presence
He gives wisdom, knowledge and happiness:
And to the wicked He has given a struggle to add and to gather,
That He may give to the good man before the presence of God:
So that even this also is perplexity and grasping of wind.

ASSYRIAN.

**3** Time is for all things:
And a season to every deed under heaven.
2 A season to be born, and a season to die:
A season to plant, and a season to pluck up the planted:
3 A season to kill, and a season to heal:
A season to destroy, and a season to build;
4 A season to weep, and a season to laugh:
A season to mourn, and a season to dance:
5 A season to throw away stones, and a season to gather stones:
A season to embrace, and a season to be far from embracing:
6 A season to seek, and a season to lose:
A season to keep, and a season to throw away:
7 A season to rend, and a season to sew:
A season to be silent, and a season to speak:
8 A season to love, and a season to hate:
A season of war, and a season of peace.

SOLOMON.

9 What profit to the worker in the things which he works?
10 I beheld all the struggle
Which God has given to the sons of men,
That they should struggle in it.

ASSYRIAN.

11 Everything which He has made is beautiful in its season ;
He hath even set all the eternity in their heart,
That man should not find out the doing which God does
From the beginning even unto the end.
12 I know that there is no good thing among them,
But to rejoice and do good in his life.
13 And indeed every man who eats and drinks
And sees good in all his labor,
This is the gift of God.

SOLOMON.

14 I know that all things which God hath made
These things shall be forever.
To Him it is impossible to add,
And from Him impossible to take away.
And God has made it
That men should fear before His Presence.
15 What has been already, is,
What shall be has happened already,
And God shall seek the driven-away.
16 And yet I saw under the sun the place of judgment,
There was the impious :
And the place of the righteous,
There was the pious.
17 And I said in my heart,
God judges the righteous and the impious :
For there is a season for everything
And for every deed, there.
18 I said in my heart concerning the talk of the sons of men,
That God judges them,
And to show that they are (but) beasts.

ASSYRIAN.

19 And indeed the end of the sons of men, and the end of the beasts,
There is one end to them (both).
As the death of this, so the death of that :
And one breath is in all.
And how doth man excel the beast ?
Nothing : for all is perplexity.
20 All (go) to one place :
All came from the dust,
And all shall return to the dust.
21 And who has seen the spirit of the sons of man,

Whether it ascends?
Or the spirit of the beast,
Whether it descends below into the earth?
22 And I saw that there is no good for man
But that he should rejoice in his works,
Because this is his portion:
For who shall bring him to see
In what it shall consist after him?

SOLOMON.

4 Then I turned, and beheld all the oppressions,
That are done under the sun.
And, behold, the tears of the oppressed,
And there is no one comforting them:
And in the hand of those oppressing there is power,
But there is no one comforting them.
2 And I praised the dead who are already dead
More than the living who are yet alive.
3 Yea good above these two
Is he who has not yet been,
Who hath not seen all that is done,
The evil done under the sun.
4 And I beheld all the labor,
And all the manliness of the doing,
That this is envy of a man from his fellow.
This indeed is perplexity and grasping of wind.

TYRIAN.

5 The fool folded his hands
And ate his own flesh.
6 Better is a handful of rest
Than two handfuls of labor and grasping of wind.

SOLOMON.

7 And I returned, and saw perplexity under the sun.
8 There is one, and there is not a second:
For there is neither son nor brother to him:
And there is no end to all his labor:
For his eye is not sated with wealth.
And for whom do I labor:
And deprive my life from goodness?
This at least is perplexity, and an evil struggle.

TYRIAN.

9 Two are better than one:
To them is a good reward in their labor:

10 For if they fall, one shall raise his fellow :
But woe to the one when he shall fall,
And there is not the second to raise him :
11 And indeed if two sleep together they have warmth :
But the one, how shall he be warmed?
12 And if one be overcome,
The two shall stand against him (their enemy),
And a threefold cord shall not be quickly broken.

SOLOMON.

13 Better is a poor and wise servant (or youth)
Than an old and foolish King
Who knows not to give heed any longer.
14 For out of the house of bondsmen (this one) shall come forth to reign,
While even in his own kingdom (the other) has become poor.
15 I saw all the living under the sun
Walking with the youth the second (or successor),
Who shall stand instead of him.
16 There is no end to all the people,
To all that were before them :
And indeed the last shall not rejoice in him :
So that even this is perplexity and grasping of wind.

TYRIAN.

17 Keep thy foot as thou walkest to the house of God ;
And let thy sacrifice be (to be) near to hear
Rather than the gift of fools;
For they know not that they do evil.
**5** Haste not with thy mouth,
And let not thy heart make haste
To bring a word before the Face of God :
For God is in the heaven above,
And thou upon the earth :
Therefore let thy words be few.
2 For a dream comes in abundance of trial,
And a voice of a fool in abundance of words.
3 According as thou shalt vow a vow unto God,
Delay not to pay it.
For there is no pleasure in fools :
Pay therefore what thou shalt vow.
4 Better for thee not to vow,
Than to vow and not to pay.
5 Let not thy mouth make thy flesh to sin,
And say not before God's Face that it is a mistake :
Lest God should be angry at thy voice,
And destroy the works of thy hands.

6 For (it is) in abundance of dreams and perplexities, and of many words,
That thou fearest God.

SOLOMON.

7 If thou seest the oppression of the poor,
And the ravaging of judgment and justice in a land,
Admire not this thing :
For there is a Lofty One to watch over the lofty,
And there are loftier ones than these.
8 And the abundance of the land over all (others)
Is the king of a well-tilled field.
9 The lover of silver shall not be satisfied with silver :
And who has loved their begettings in (its) abundance?
This indeed is perplexity.

TYRIAN.

10 In abundance of goods those eating them are multiplied :
And what manliness to him from it?
That it is the government of seeing (it) with his eyes.
11 Sweet is the sleep of the slave,
Whether he eat little or much :
12 But to the one abounding in wealth
There is that prevents him from sleep.

SOLOMON.

13 There is a sore evil which I have seen under the sun :
Riches kept for one's own for evil to himself,
And that riches is destroyed in an evil struggle;
And he hath begotten a son, and there is nothing in his hand.
14 As he came naked from the womb of his mother,
(Naked) he shall return to go as he came :
And nothing shall be left of his labor,
That he may go (with it) in his hand.
15 And this indeed is an evil sickness (sore evil),
That as he came so shall he go :
And what his advantage in what he labors for the wind?
16 And all his days are in darkness
And in grief and much rage
And in sickness and vexation

TYRIAN.

17 Behold what I have seen good :
It is good to eat and drink,
And to see good in all one's labor,
Wherein one may labor under the sun
The number of the days of his life
Which God hath given him : for this is his portion.

18 And indeed every man to whom God gives wealth and possessions,
And has permitted him to eat of it,
And to take his portion, and to rejoice in his labor,
This is the gift of God.
19 For he shall not remember the days of his life:
For God shall scatter him in the joy of his heart.

SOLOMON.

**6** There is an evil which I have seen under the sun,
And it is great among men.
2 A man to whom God shall give wealth, possessions and honor,
And there lacks nothing which his soul may desire:
And God permitteth him not to eat of it,
But a stranger eats it.
This is perplexity, and an evil disease.

EGYPTIAN.

3 If a man shall beget a hundred (children)
And shall live many years,
And the days of his years be abundant,
Yet his soul shall not be filled with good,
And even he had no burial—
The untimely-born is better than he.
4 For into perplexity it came,
And into darkness it goes:
And in darkness its name shall be hidden.
5 For indeed it saw not the sun:
And he knew not rest:
(The advantage is) to this over that,
6 Though he lived the courses of a thousand years
And knew not good—
Do not all go to one place?

SOLOMON.

7 All the labor of man is for his mouth:
And yet his soul shall not be satisfied.
8 Because there is advantage to the wise man over the fool,
Therefore the poor man knows how to walk in presence of life.
9 Better is the sight of the eyes, than the longing in the soul.
This also is perplexity, and grasping of wind.

ASSYRIAN.

10 If anything has already been its name has been called:
And it is known what is man,
And he shall not be able to contend with the Stronger than he.
11 For there are many words which multiply perplexity.

7 What is the advantage to man?
For who knows what is good for man in life,
The number of his days of his perplexity?
For He hath made them in a shadow:
For who shall announce to a man
What shall be after him under the sun?

EGYPTIAN.

2 A good name is better than good ointment,
And the day of death than the day of birth.
3 It is better to go to the house of mourning than to the house of feasting:
For this is the end of every man,
And the living shall give good to his heart.
4 Anger is better than laughter:
For in severity of the face the heart shall be made better.

SOLOMON.

5 The heart of the wise is in the house of mourning,
But the heart of fools is in the house of joy.
6 Better to hear the rebuke of the wise
Than to listen to the song of fools.
7 Like the crackling of thorns under the pot,
So is the laughter of fools.

TYRIAN.

This also indeed is perplexity,
8 That oppression carries away a wise man
And destroys the heart of his nobleness.
9 Better is the end of strife than the beginning of it:
Better the patient than the proud in spirit.
10 Haste not in thy spirit to be angry:
For rage dwells in the bosom of fools.
11 Say not of what was, that former days were better than these:
For not in wisdom hast thou inquired about this.

SOLOMON.

12 Wisdom is better than an inheritance,
Yea, an advantage to those seeing the sun.
13 For in its shelter wisdom is as the shelter of silver:
And abundance of knowledge of wisdom shall make one alive through it.

ASSYRIAN.

14 Consider the works of God:
Who can adorn him whom God has overturned?

15 In the day of good live in the good:
And consider in the day of evil.
Consider indeed: God has made this harmoniously with that, concerning talk,
That man should find nothing beyond him.

TYRIAN.

16 I have seen all these things in my perplexity.
There is a righteous man, destroyed in his righteousness:
And there is a wicked man, remaining in his wickedness.
17 Be not righteous over much,
Nor be excessively wise—
Lest thou perish:
18 Be not wicked over much,
And become not hardened—
Lest thou die before thy time.
19 It is good to restrain thyself in this,
And indeed not to soil thy hand with that—
All things shall come to those who fear God.

SOLOMON.

20 Wisdom shall help a wise man
More than ten powerful ones in a city.

TYRIAN.

21 For there is no just man in the earth,
Who shall do right and not sin.
22 And indeed lay not to heart all words spoken by the wicked,
That thou hear not thy slave curse thee:
For very often it would do thee harm,
And afflict in many ways thy heart:
23 Because so also thou hast cursed others.

SOLOMON.

24 All these things have I proved in wisdom:
I said, I will become wise:
25 But she (wisdom) was far from me,
Beyond where she had been—
A depth of depth—who shall find it?
26 I turned about, I and my heart,
To know and to seek and to search out
Wisdom, and a sure calculation:
And to know the folly and hardness
And madness of the impious:
27 And I find it, and declare it more bitter than death.
Even as the woman who is a snare;
Her heart is a net;

Bonds are in her hands.
The good man before the Face of God
Shall be snatched away from her:
And the one sinning shall be taken with
28 Behold this did I find, said the Ecclesiast,
One by one to find a disputing;
29 Which my soul sought, and I found not—
And I found one man among a thousand,*
And a woman in all these I found not.
30 But behold this I found—
What God has done with man is right:
But they have sought many disputings.

EGYPTIAN, ASSYRIAN, TYRIAN.

Who knows the wise
And who knows the solution of the thing?

SOLOMON.

8 Wisdom enlightens a man's countenance:
And the shameless in his face shall be hated.
2 Watch the mouth of the King,
And haste not concerning the word of the oath of God.
3 Go from His Presence,
Stand not in wicked word:
For He shall do whatever He pleaseth,
4 As a King having authority:
And who shall say, What doest thou?
5 He that keeps the commandment
Shall not know an evil thing;
And the heart of the wise
Knoweth the season of judgment.
6 For to everything is a season, and a judgment:
So that the knowledge of a man is great to him.
7 For there is none who knoweth what shall be;
For how it shall be, who shall announce to him?
8 There is no one that hath power over the spirit,
That he may retain the spirit:
And there is no power in the day of death,
And there is no discharge in the day of (that) war:
And impiety shall not save that belonging to it.

TYRIAN.

9 This all have I seen:
And I applied my heart to every work,
Which is done under the sun:
In how many things man has authority over man to afflict him.

* See Proverbs viii and ix.

10 Then I saw the impious borne to the graves,
And from the good they went away :
And they praised them in the city
Because they had done thus.

SOLOMON.

This also is perplexity,
11 That sentence against doers of evil is not swift :
Therefore the heart of sons of men is abundantly filled to do evil.
12 Whoever has sinned has done evil :
From that time is also away from their greatness.
For this I know,
That it is good to those who fear God :
That they may fear before His Face.
13 And there shall be no good to the impious :
And he shall not prolong his days in shade,
Who feareth not before the Face of God.

ASSYRIAN.

14 There is a perplexity wrought upon the earth,
That there are righteous,
To whom it happens as to the deed of the impious :
And there are wicked,
To whom it happens as (to) the deed of the just.
I have said that this indeed is perplexity.
15 And I praised mirthfulness :
For there is nothing good for a man under the sun
But that he should eat and drink and rejoice :
And this shall be his advantage
In his labor all the days of his life,
Which God has given him under the sun.
16 In which I gave my heart to know wisdom,
And to behold the struggle made upon the earth :
For both day and night
There is no one seeing sleep with his eyes.
17 And I beheld all the work of God,
That a man shall not be able to find out thoroughly
All the work done under the sun.
Though a man should labor to seek,
Yet shall he not find out :
However a wise man may say he knows it,
He shall not be able to find it.
For to all this I gave my heart :
And my heart hath known all this.
**9** As well the righteous and the wise,
As their works, are in the hand of God :
And so also love and hate.

There is no man hath known all things before their face :
Perplexity in them all.
2 There is one ending to the righteous and impious,
To the good and to the wicked :
To the clean and the unclean,
To the sacrificer, and to him that sacrificeth not :
As is the good, so is the sinner :
As the swearer, so the one fearing an oath.

SOLOMON.

3 This were an evil in all done under the sun
That there were one end to all.
And indeed the heart of the sons of men has been filled with evil :
And madness is in their hearts during their life,
And after them among the dead.
4 For who is He that gives to all the living?

TYRIAN.

There is hope for the living dog :
He is better than the dead lion.
5 For the living know that they shall die,
But the dead know not anything.
And there is no longer for them a hire,
For their memory has been blotted out.
6 And even their love and their hate,
And their desire has perished.
And there is no portion still forever
In all done under the sun.
7 Go : eat in mirth thy bread :
Drink in good heart thy wine :
God is well pleased with thy doings :
8 Be clothed at every season in white garments,
And stint not oil on thy head :
9 And see life with the wife whom thou lovest,
All the days of the life of thy perplexity,
Which has been given thee under the sun ;
For this is thy portion in thy life,
And in the labor thou laborest under the sun (!)
10 Whatsoever thy hand findeth to do
Do it with thy might
For there is no deed nor reasoning
Nor knowledge nor wisdom
In Hades, whither thou goest (!)

SOLOMON.

11 I returned : and saw under the sun
That not to the swift is the race,

Not to the mighty the battle,
Not to the wise man bread,
Not to the prudent wealth,
Not to the knowing favor :
For season and chance happen to them all
12 For indeed a man has not known his season ·
Like the fishes taken in an evil net
And like birds captured in a snare,
So are snared the sons of men in an evil season.
When it falls upon them suddenly.

ASSYRIAN.

13 And indeed I saw this wisdom under the sun,
And it is great to me.
14 If a city be small and the men in it few,
And a great king come against it
And besiege it and build great bulwarks against it ·
15 And there be found in it a poor wise man,
And he save the city by his wisdom,
No man remembered the poverty of that man.
16 And I said, Wisdom is greater than power :
And yet the wisdom of the poor man is scouted,
His words are not listened to.

SOLOMON.

17 The words of the wise are heard in refreshment
More than the shoutings of rulers among fools.
18 Wisdom is better than weapons of war ;
And one sinner will destroy much good :
**10** (So) dead flies corrupt the preparation of oil of fragrance.
Better a little honor for wisdom
Than great glory for folly.

EGYPTIAN.

2 The heart of the wise is at his right
But the heart of the fool at his left.
3 Indeed, whenever the fool goeth in the way
His heart faileth him :
Whatever he thinks it is folly.
4 If the spirit of the ruler rise against thee
Leave not thy place :
For forbearance heals great sins.

TYRIAN.

5 There is an evil which I have seen under the sun :
As something not intended it proceeded from the face of the ruler
6 A fool was presented with great exaltations :
And the wealthy shall sit with the humble.

7 I saw slaves upon horses,
And rulers walking as slaves on the earth.

ASSYRIAN.

8 The digger of a ditch shall fall into it:
And a serpent shall bite the destroyer of a hedge.

EGYPTIAN.

9 The remover of stones shall be hurt by them :
The splitter of wood shall be endangered by it.

TYRIAN.

10 If the axe fail, he has disturbed its face,
And he must labor labors :
That man's wisdom is not excessive.
11 If a serpent bite through not having been charmed,
There is no advantage to the charmer.

SOLOMON.

12 The words of the mouth of the wise are grace :
But the lips of the fool shall drown him.
13 The beginning of the words of his mouth is folly,
And the last of his mouth is wicked madness :
14 And the fool multiplies words.

ASSYRIAN.

Man knoweth not what hath been
Nor what shall be :
For (that which comes) after who shall tell him?
15 The labor of fools afflicts them :
He knoweth not how to go to the city.

TYRIAN.

16 Woe to thee, city,
Whose king is young,
And whose rulers eat in the morning!
17 Happy thou, O land,
Whose king is son of the free,
Whose rulers eat in season,
For strength, and shall not be ashamed!
18 Through sloth the roof will be abased,
And in idleness of hands the house will leak.
19 For laughter do they prepare bread and wine,
And oil to make glad the living :
And to the expenditure of silver
Shall all things be obedient.

EGYPTIAN.

20 And indeed curse not the King in thy thought,
In thy bedchamber curse not the rich:
For a bird of the air shall carry thy voice,
And that which has wings shall tell thy speech.
11 Cast thy bread upon the face of the waters :
For in fullness of days thou shalt find it.
2 Give a portion to seven, aye to eight :
For thou knowest not what evil shall be on the earth.

ASSYRIAN.

3 If the clouds be full of rain
They empty themselves on the earth :
Whether the tree falls to the South
Or whether it falls to the North,
In the place where the tree falls
There it shall be :
4 The one watching the wind sows not,
The one gazing at the clouds shall not reap :
5 In which there is none who knows the way of the spirit.

SOLOMON.

As the bones (grow) in the womb of a woman with child
So thou knowest not the works of God,
All the things that He doeth.
6 In the morning sow thy seed,
And in the evening hold not thy hand :
For thou knowest not which shall flourish,
Whether this or that :
Or whether both shall be alike good.
7 Sweet is the light,
And good to the eyes to behold the sun :
8 For if a man should live many years,
Let him rejoice in them all :
Yet let him remember the days of darkness,
For they shall be many :
All that cometh is perplexity.
9 Rejoice, oh young man, in thy youth :
And let thy heart cheer thee in the days of thy youth :
And walk blameless
In the ways of thy heart,
And not in the sight of thine eyes :
And know that in all these things
God will bring thee into judgment.
Therefore put away wrath from thy heart,
10 And remove wickedness from thy flesh :
For youth and thoughtlessness are perplexity.

12 And remember thy Creator
In the days of thy youth :
Before the evil days come
And the years touch, when thou shalt say
I have no pleasure in them.
2 Before the sun and the light be darkened,
And the moon and the stars ;
And the clouds return after the rain.
3 In the day when the keepers of the house tremble,
And the men of might are turned aside,
And the grinders cease because they are few,
And those looking out of the windows shall be darkened,
4 And they shall close the doors in the street,
In weakness of voice of the grinder ;
And he shall rise at the voice of the ostrich,
And all the daughters of song shall be abased.
5 And they shall look to the height,
And terrors be in the way :
And the almond shall blossom,
And the grasshopper be heavy,
And the caper-berry be scattered :
Because a man has gone to the house of his eternity,
And the mourners have gone about the streets.
6 Or ever the silver cord be untwisted :
Or the golden bowl broken :
Or the pitcher be broken at the spring :
Or the wheel overturned at the cistern :
7 Or the dust returned to the earth as it was,
And the spirit returned to God who gave it.

SUMMING UP BY THE PRESIDING OFFICER.

8 Perplexity of perplexities, as said the Ecclesiast,
All is perplexity.

9 And moreover because the Ecclesiast was wise,
Because he thoroughly taught man knowledge,
And the ear shall trace out the adornment of parables,
10 The Ecclesiast sought many things
To find acceptable words,
And the writing of correctness,
Words of truth.

11 The words of the wise are as goads,
And as spikes well planted :
They of the assemblies
Gave them from one shepherd.

12 And moreover by them my son, be warned:
Of making many books there is no end :
And much anxious thought
Is a weariness of the flesh.

The end of the discourse, the whole, listen to :
13 Fear God :
And keep His commandments :
For that is the whole (of) man.
14 For God will bring every deed into judgment :
With every hidden thing,
Whether it be good
Or whether it be evil.

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## *The Atomic Mass of Tungsten.*

*By Mary E. Pennington and Edgar F. Smith.*

*(Read before the American Philosophical Society, November 2, 1894.)*

A study of the literature relating to this subject discloses the fact that while, in most instances, every effort was made to eliminate foreign matter from the material employed in the numerous investigations which have been conducted at various times, several doubtful points continue. The object of this communication is to direct attention to one of these possible sources of error, viz., the presence of traces of molybdenum, and to present results obtained after its evident removal.

The earlier investigations relating to the atomic mass of tungsten are rather numerous; but of these that of Schneider is without doubt deserving of the most confidence, chiefly for the pains taken in preparing pure material for the later experiments. The author offers satisfactory evidence of the absence of possible contaminating substances, and in writing of the presence of molybdenum employs these words: "Molybdän endlich nicht, weil die Molybdänsäure in heftiger Glühhitze flüchtig ist" (*Journ. prakt. Chemie*, *50*, p. 158). The experience of chemists generally is that a complete separation of tungsten trioxide from molybdenum trioxide cannot be attained in this way. Indeed, an examination of the experiments recorded by Schneider discloses the fact that he, while engaged in reducing strongly ignited tungsten trioxide, several times discovered on the anterior portion of the reduction or combustion tube "ein weissliches Sublimat." This sublimate Schneider attributes to tungsten chloride, but the question may well be asked, Was it not molybdic acid?

Waddell has made the most recent contribution to our knowledge upon the atomic mass of tungsten (*Amer. Chem. Journ.*, *8*, 280). He experi-

enced much difficulty in obtaining pure tungsten trioxide. He found by considerable investigation that Rose's method for the separation of molybdenum and tungsten was the most convenient. Traube (*Jahr. für Mineralogie*, etc., Beilageband, 7, 232) and more recently Friedheim (*Z. für anorg. Chemie*, *1*, 76) has shown that this procedure does not entirely eliminate the molybdenum. Recent investigations, in this as well as in other laboratories, upon artificial and supposedly pure, as well as natural tungstates have proved that these all contain molybdenum in appreciable amounts, and it may well be questioned whether the earlier determinations of the atomic mass of tungsten were not affected by the presence of traces of molybdenum. Its complete and absolute removal would tend to raise the value of this constant of tungsten. An effort to this end appeared to be desirable.

An attempt was first made to free the trioxide from impurities through the sodium salts. This course was abandoned inasmuch as traces of alkali persistently adhered to the tungsten. This fact is not new; Schneider was fully aware of it, and in consequence he had recourse to another method, which was also adopted in this investigation with some modifications.

A quantity of tungsten trioxide, derived from wolframite, was heated in a porcelain dish for three days with concentrated nitric acid. The latter was then decanted and the yellow oxide was well washed with water. It was next subjected to the action of boiling *aqua regia* for the same length of time, the acid solution, however, being removed from time to time. The washings and acid liquor were tested for iron. When this was no longer detected the washed trioxide was dissolved in yellow ammonium sulphide, air being excluded as much as possible. The solution was filtered from insoluble material, and concentrated almost to the point of crystallization, when hydrochloric acid was added. The liquid was removed from the resulting precipitate, which was ignited, then boiled with nitric acid, and later with *aqua regia*. The resulting trioxide no longer showed the presence of iron and manganese. It was then washed, brought into a porcelain dish, covered with distilled water and ammonia gas conducted over the liquid until it was saturated. Several days were required for this purpose. Only a very small residue remained undissolved. It contained a trace of silica and a little greenish-yellow oxide. Hydrogen sulphide gas was next introduced into the ammoniacal solution, which was then digested at 80° C., for several hours. On the addition of pure dilute hydrochloric acid to this solution tungsten trisulphide was precipitated. This was filtered out, washed and roasted in a large porcelain crucible with air access. The trioxide prepared in this manner no longer contained silica, iron or manganese. If tin had been originally present it would have gone out with the *aqua regia*, and any columbic acid would have remained when the trioxide was subjected to the ammonium sulphide treatment. The next step was to prove the presence or absence of molybdenum. A portion of the purified tungsten trioxide was converted into the ammonium salt and the sulphocyanide test

(Braun, *Zeit. f. Analyt. Chemie*, *2*, 36) for molybdenum applied to its aqueous solution. The presence of molybdenum was very evident. The ignition of the tungsten trioxide in the earlier stages of purification had not eliminated this constituent. Instead of adopting Rose's method as was done by Waddell, and thus introducing the possible contamination from a fixed alkali, recourse was had to the reaction of Debray—the volatilization of the molybdic acid as oxychloride—$MoO_3 . 2HCl$ (*Compt. rend.*, *46*, 1098, and Liebig's *Annalen*, *108*, 250). The experiments of Péchard (*Compt. rend.*, *114*, 173, and *Zeit. f. anorg. Chemie*, *1*, 262), as well as those more recently made by Smith and Oberholtzer (*Journ. Am. Chem. Soc.*, *15*, 18, and *Zeit. f. anorg. Chemie*, *4*, 236), and by Smith and Maas (*Journ. Am. Soc.*, *15*, 397, and *Zeit. f. anorg.. Chemie*, *5*, 280), give evidence that by this means molybdenum can be expelled from tungsten derivatives. To this end the remainder of the tungsten trioxide was placed, in portions, in a porcelain boat and exposed to the action of hydrochloric acid gas, aided by a gentle heat (150–200° C.), until a volatile sublimate of $MoO_3 . 2HCl$ was no longer noticed. Upon reoxidizing the residual tungsten trioxide in open porcelain crucibles and then subjecting portions of the same to the sulphocyanide test the presence of molybdic acid was no longer observed. This was taken as an evidence of its complete removal.

The trioxide subjected to the treatment described in the last paragraph was suspended in water into which ammonia gas was conducted. The oxide dissolved without leaving a trace of foreign matter. The salt obtained upon evaporation was crystallized three times ; it was then dried and ignited with careful exclusion of dust. This material was now regarded as sufficiently pure for the experiments projected. As it was not intended to attempt any determinations by reduction of the oxide, the latter was reduced in a current of hydrogen, carefully purified, to the metallic state. The reductions were made in a large platinum crucible after the manner of Von Pfordten (*Ber. d. deutsch. Chem. Gesell.*, *17*, 731). Inasmuch as the reduced metal slowly alloys with the platinum the resulting metallic powder was in all instances gently shaken from the crucible after it had cooled in a current of hydrogen. The reduction of trioxide proceeds quite rapidly in the above manner and is always complete. The product is dark gray in color. Its specific gravity was found to be 18.64 at 0°. It was carefully preserved from dust and moisture in drying bottles.

The amount of oxygen absorbed by the conversion of tungsten into its trioxide was made the basis of the determinations recorded in this paper.

The oxidations were made in porcelain crucibles. These were supported in close-fitting asbestos rings so that reducing gases could not gain access to the hot oxide. To avoid loss from particles being carried out mechanically a porcelain lid wider than the crucible was placed over it, at the height of one-half inch. A careful examination of this lid from time to time showed no traces of tungstic oxide. Dust particles were also excluded in this manner. No other work was done in the room in

which these oxidations were performed. All draughts were avoided. The crucibles were handled with nickel crucible tongs. They were allowed to cool in vacuum desiccators over sulphuric acid. Calcium chloride cannot apparently be used for this purpose, at least a superficial greenish tinge was always noticed on the oxide cooled in this way. Direct sunlight also causes a reduction of the trioxide, therefore the desiccators were kept covered with a black cloth.

At the beginning of each oxidation the flame applied was quite small. The metal increased in bulk as it oxidized, and in five minutes had assumed a light yellowish-green color. At the expiration of half an hour the heat was increased. Later a stronger heat was allowed to act and continued until the oxidation was finished. The first period of each oxidation continued through five hours. The crucible and contents were cooled and weighed. The second period lasted three hours additional, after which the crucible was allowed to cool. It was again weighed, and even if there was no change in weight from that first recorded, the ignition was continued for two hours more. The third weight, if constant, was taken as final. Each oxidation, therefore, was not considered finished until it had been continued through a period of at least ten hours.

The weighings were made upon a Becker balance with weights, which had been adjusted for this work. The vacuum standard was observed, and oxygen taken equal to sixteen in all the calculations. The results were as follows:

| | WEIGHT OF TUNGSTEN IN GRAMS. | WEIGHT OF OXYGEN IN GRAMS. | ATOMIC MASS OF W. |
|---|---|---|---|
| 1. | 0.862871 | 0.223952 | 184.942 |
| 2. | 0.650700 | 0.168900 | 184.923 |
| 3. | 0.597654 | 0.155143 | 184.909 |
| 4. | 0.666820 | 0.173103 | 184.902 |
| 5. | 0.428228 | 0.111168 | 184.900 |
| 6. | 0.671920 | 0.174406 | 184.925 |
| 7. | 0.590220 | 0.153193 | 184.933 |
| 8. | 0.568654 | 0.147588 | 184 943 |
| 9. | 1.080973 | 0.280600 | 184.913 |
| | | Mean........ | 184.921 |

Maximum........................................... 184.943
Minimum........................................... 184.900

.043

Clarke (*Recalculation of the Atomic Weights*, 1882, Washington) and Becker (*Atomic Weight Determinations*, 1880, Washington) in their recalculations of this constant of tungsten both arrive at the figures 184.02

(O=16), while Ostwald (*Outlines of General Chemistry*, translated by Walker, 1890, p. 80) says, "the mean of the good determinations is W=184" Waddell (*Amer. Chem. Jr.*, *8*, 280) gives as the mean of his determinations 184.5 (O=16). The results presented in this communication show, therefore, a wide difference from those usually looked upon as most correct.

The evidence in earlier papers of the absence of molybdenum from the tungsten is far from satisfactory. Waddell recognizes this; hence he employs Rose's method for the removal of molybdenum from his starting-out material. Since the publication of his research other experimenters have declared and proved the insufficiency of this method (Traube, Friedheim, *loc. cit.*) for the purpose to which Waddell applied it. For this reason the Rose method was not followed in this present investigation, as well as from fear that it might introduce alkali, difficult to eliminate. As a substitute for it the method of Debray was adopted.

In considering the factors that possibly could have caused a rise in the atomic value other than that occasioned by the complete removal of molybdenum, two suggest themselves. First, the occlusion of hydrogen by the finely divided metallic tungsten, upon cooling in that gas, would produce such a result. Waddell (*loc. cit.*) by one experiment is satisfied that such gas occlusion does not occur. Derenbach (*Inaug. Dissertation*, Würzburg, 1892) claims that there is an appreciable retention of hydrogen by the finely divided metal. The question is therefore one of importance, and while this communication contains no data on this point, yet if an occlusion equal to that claimed by Derenbach (*Dissertation*, p. 43) be granted to have occurred in each experiment recorded in this investigation the final result would not be equal to that actually obtained. We must therefore look further for the cause of the rise in the atomic value. The reductions of the trioxide were made in a platinum vessel. An examination of the metallic tungsten for platinum did not show its presence.

Again, tungsten trioxide volatilizes slightly at elevated temperatures; its escape would operate to augment the final value of the tungsten constant. There is, however, no evidence that loss in this way did occur, for the porcelain lid suspended over the crucible during the long ignition period never showed the presence of trioxide. Even if such a volatilization had taken place, it is not at all probable that three weighings could have been made with no change in the same. Furthermore, the remarkable concordance of the individual results among themselves precludes the idea that the rise in the found atomic mass is attributable to volatilization of trioxide. In the end it seems most reasonable to assume that the new value is due to a full and complete elimination of the last traces of molybdenum from the tungsten prior to its oxidation.

Chemical Laboratory, University of Pennsylvania,
November, 1894.

## *The Atomic Mass of Tungsten.*

*By Edgar F. Smith and En. D. Desi.*

*(Read before the American Philosophical Society, November 2, 1894).*

Most of the experiments made to determine this constant consist in reduction of the trioxide and the subsequent oxidation of the metal. Two experimenters have attempted to weigh the water produced in the reduction of the trioxide. A. Riche (*Annal de Chim. et de Phys.*, (3) *50*, 10, 1857) made five such trials. The atomic mass of tungsten, deduced from his experiments, equals 174 (O=16). Three years later Bernoulli (*Pogg. Ann.*, iii, 599) made two experiments and his recorded value for the constant is 186+. In both instances there is considerable variation in the individual results.

In a previous paper by Pennington and Smith a value (184.9) was obtained that differs quite appreciably from that usually accepted as representing the true atomic mass of the element under discussion. We have undertaken in this present investigation to determine the atomic value from the quantity of water formed in the reduction of the trioxide chiefly for the purpose of ascertaining whether the elimination of the last traces of molybdenum would likely produce the great rise in atomic mass. It will be remembered that great stress was laid upon this point by Pennington and Smith. In the preparation, therefore, of our trioxide we adhered closely to their method of purification and observed all precautions laid down by them. For details, therefore, we would refer the reader to their paper.

The hydrogen used by us in the reductions was prepared from sulphuric acid and the purest zinc obtainable. To purify the gas it was conducted through a series of bottles containing potassium permanganate, an alkaline lead nitrate solution, silver nitrate, caustic potash, sulphuric acid, calcium chloride, and finally through a glass tube nine inches long, filled with bright, polished iron wire. The latter was heated constantly with a Bunsen burner. After this the gas was admitted to the tube where it came in contact with the ignited trioxide, contained in a platinum boat. The water produced in the reduction was collected in a weighed, glass-stoppered U-tube, filled with anhydrous calcium chloride. A similar tube was attached to this to prevent absorption of moisture from the surrounding atmosphere.

All weighings were reduced to the vacuum standard, and in the calculations oxygen was taken as *16* and hydrogen as 1.008 (Clarke).

*Results.*

| $WO_3$ | $H_2O$ | AT. MASS W. |
|---|---|---|
| 0.983024 | 0.22834 | 184.683 |
| 0.998424 | 0.23189 | 184.709 |
| 1.008074 | 0.23409 | 184.749 |
| 0.911974 | 0.21184 | 184.678 |
| 0.997974 | 0.23179 | 184.704 |
| 1.007024 | 0.23389 | 184.706 |
| | Mean........ | 184.704 |

| | |
|---|---|
| Maximum........................................ | 184.749 |
| Minimum........................................ | 184.678 |
| Diff........................................ | .071 |

The mean *184.704* falls below that given by Pennington and Smith. The discrepancy may possibly be due to the method, or the personal factor entering into the work may account for it. However, the result we believe clearly proves that the atomic mass of tungsten is certainly greater than what is generally assumed as correct, and in all likelihood the molybdenum contained in the tungsten has caused the low values found by previous experimenters.*

Chemical Laboratory, University of Pennsylvania,
November, 1894.

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## *Notices of Presumably Undescribed Infusoria.*

*By Dr. Alfred C. Stokes.*

(*Read before the American Philosophical Society, November 2, 1894.*)

*Salpingœca globosa*, sp. nov. (Fig. 1).—Lorica pedicellate, carafe-shaped, the body subspherical, tapering at the posterior extremity to the pedicle; neck conspicuous, about one third as long as the body of the lorica, the margin flaring; pedicle often oblique, somewhat flexuous, and about as long as the entire lorica. Solitary. Length, $\frac{1}{2250}$ inch. *Hab.*—Fresh water, near Trenton, N. J.; attached to filamentous algæ.

*Salpingœca collaris*, sp. nov. (Fig. 2).—Lorica vasiform, less than four times as long as broad, but divisible by its characteristic contour

* A review of all the methods heretofore used in determining the atomic mass of tungsten has been begun by one of my assistants. Care is being taken to completely eliminate certain sources of error which have not been absolutely excluded in earlier work. —E. F. S.

into two regions, a posterior, inflated, obovate portion, tapering to the pedicle, and an anterior region, subcylindrical, somewhat exceeding the posterior region in length, its lateral margins parallel, the anterior aperture circular, its borders everted ; pedicle usually exceeding the lorica in length ; enclosed animalcule freely motile within the lorica, at times situated exclusively within the frontal, neck-like portion, at others extending into the anterior region of the posterior part of the sheath ; when disturbed retreating into the posterior region, and advancing to the frontal portion when its fright has passed, the sarcode then completely filling that part of the lorica and taking its shape. Length of lorica $\frac{1}{1200}$ inch. *Hab.*—Standing water from the Morris and Essex canal, New Jersey.

The water in which this beautiful and characteristic form was found was taken from the canal late in the autumn of 1891, by Mr. S. Helm, of New York city, and by him sent to me. It remained on my table until February 17, 1892, almost unnoticed, except that a little water was occasionally added to supply that lost by evaporation. On the date last mentioned the animalcule was found in some abundance, attached to various submerged fragments and in company with a profusion of *Salpingœca gracilis* J. Clk., a form which it somewhat resembles, and near to which it should be classified.

*Prorocentrum hamatum*, sp. nov. (Fig. 8).—Body ovate, less than twice as long as broad, smooth, depressed, the lateral borders slightly flattened, the posterior margin evenly rounded and obtusely pointed ; dorsal surface convex ; ventral aspect somewhat flattened, bearing on its frontal margin a stout, anteriorly projecting, obtusely pointed, often colorless process, which is bent hook-like almost at a right angle, directed towards the left-hand side and slightly excavated dorsally, thus exhibiting a ledge-like or shelf-like projection towards that aspect of the body ; frontal border truncate, surrounded, within the margin, by an annular groove, the right-hand and left-hand ventral continuations of which extend obliquely along the adherent posterior prolongation of the frontal process and unite to form a subcentral, longitudinal ventral depression ; anterior flagellum spirally undulating, taking its origin from within the ventral portion of the anterior groove, on the left-hand side of the posterior prolongation of the hook-like process, and extending round the frontal border into the groove on the right-hand side of the frontal projection ; ventral flagellum long, trailing, vibratile, taking its origin from near the central region of the ventral groove ; nucleus subspherical, located near the posterior extremity, often with an apparently amylaceous corpuscle on one side and near it. Chromatophores linear, elongate, vermicular or variously curved. Length, $\frac{1}{500}$ inch. *Hab.*—Brackish water from a salt marsh on Coney Island, N. Y. Movements rotary on the longitudinal axis. Abundant.

This form was collected and sent to me by Mr. H. C. Wells, of Short Hills, N. J.

Although *Trachelomonas* is probably not an infusorian, the following descriptions are here included for convenience.

*Trachelomonas fusiformis*, sp. nov. (Fig. 4).—Lorica fusiform, three times as long as broad, punctate with minute, scattered, conical elevations which are larger and more conspicuous near the margin of the posterior prolongation; anterior region narrowed, neck-like, the frontal border slightly everted, the margin minutely denticulate; color brown. Length of lorica, $\frac{1}{375}$ inch. *Hab.*—Pond water, near Trenton, N. J.; movements tremulous and rotary on the longitudinal axis.

*Trachelomonas sphærica*, sp. nov. (Fig. 5).—Lorica subspherical, somewhat depressed, the anterior aperture produced into a short, cylindrical, neck-like region, its frontal margin with four or more obtuse denticulations; entire surface of the lorica armed by long, conspicuous, obtuse spinous processes, the largest of which are subequal in length to the length of the neck-like portion of the sheath; color reddish brown; flagellum in length equaling or exceeding the circumference of the lorica. Diameter, including the length of the spinous processes, $\frac{1}{860}$ inch. *Hab.*—Pond water, with *Lemna*, near Trenton, N. J. Movements rapidly rotary.

*Trachelomonas acanthophora*, sp. nov. (Fig. 6).—Lorica fusiform, about twice as long as broad, the posterior region somewhat suddenly contracted into a short, naked, punctate or smooth, prolongation, terminated by three diverging spines; anterior region produced as a neck-like portion, naked and punctate or smooth, the anterior border truncate, the margin bearing four or more radiating spines; central or body-region armed by numerous, conical, spine-like prolongations; flagellum equaling or exceeding the lorica in length; endoplasm green. Length of lorica, including spines, $\frac{1}{500}$ inch; width, without spines, about $\frac{1}{1200}$ inch. *Hab.*—Pond water, with *Lemna*, near Trenton, N. J. Movements rotary on the longitudinal axis.

*Vaginicola longipes*, sp. nov. (Figs. 7, 8).—Lorica trumpet-shaped, much compressed, rather more than four times as long as broad, widest and inflated near the middle third, thence tapering posteriorly to a narrow, irregularly subcylindrical region forming from one-third to one-half of the entire length of the lorica; anterior border slightly everted, the lateral margin somewhat constricted beneath the frontal region; lorica often irregularly constricted, the posterior, pedicle-like portion frequently curved, and variously contorted, bent or irregularly inflated, the whole becoming chestnut-brown with age; enclosed animalcule adherent posteriorly to a long, narrow pedicle apparently attached to the posterior extremity of the lorica, but often there becoming indistinct, and at times seemingly adherent to one lateral margin; body soft and flexible, finely striate transversely, extending slowly and irregularly, often undulate or vermicular in form, the contracted anterior region bending posteriorly, the flexure thus produced advancing towards the anterior aperture of the lorica, the unexpanded peristomal region apparently wedged against the lateral borders of the sheath, the animalcule thus remaining until another

contraction changes its position; extended body elongate, very narrow, projecting for from one-third to one-half its length, or more, beyond the frontal aperture; peristome broad, somewhat oblique; contracted body obovate; nucleus elongate, narrow, band-like, exceedingly tortuous during the contracted state of the animalcule; contractile vesicle single, spherical, anteriorly situated. Length of lorica, about $\frac{1}{90}$ inch. *Hab.*—Attached to aquatic plants from Rancocas creek, at New Lisbon, N. J.

*Caulicola* (*caulis*, stem; *colo*, to inhabit), gen. nov.—Animalcules loricate, as in *Thuricola*, except that the lorica is conspicuously pedicellate, and possesses a valve-like appendage which is not attached to the wall within the lorica, as in *Thuricola*, but to the lateral margin of the anterior aperture.

*Caulicola valvata*, sp. nov. (Fig. 9).—Lorica ovate, less than twice as long as wide, posterior border rounded, somewhat inflated, thickened centrally and with a short, posterior projection at its point of attachment to the pedicle; lateral walls often slightly undulate, and usually narrowed at the truncate, anterior aperture; valve-like appendage attached to the lateral border of the anterior aperture, rising by the pressure of the extending animalcule, and when fallen, completely closing the orifice by a horizontal, flat-topped lid; pedicle slender, thickened centrally, and with a short anterior projection at its point of attachment to the lorica, tapering posteriorly, and about one-third as long as the lorica; body of enclosed animalcule colorless, transparent, and when extended, protruding about one fourth of its length beyond the lorica; cuticular surface transversely striate; nucleus elongate, band-like. Length of lorica, $\frac{1}{500}$ inch. *Hab.*—Brackish water from Coney Island, N. Y. Collected and sent to me by Mr. H. C. Wells, of Short Hills, N. J.

*Bicosœca phiala*, sp. nov. (Fig. 10).—Lorica elongate-vasiform, less than twice as long as broad, widest anteriorly, tapering posteriorly to the pedicle; anterior margin everted, truncate; lateral borders often almost rectilinear; pedicle short; enclosed animalcule not exserted; contractile vesicles two or more, often four, near the posterior extremity; nucleus not observed. Length of lorica, $\frac{1}{1285}$ inch. *Hab.*—Pond water from near Trenton, N. J.; attached to filamentous objects.

*Enchelyodon vesiculosus*, sp. nov.—Body elongate-ovate, one lateral border somewhat concave, the other convex; both extremities rounded, the anterior somewhat truncate; soft, flexible and changeable in shape; about twice as long as broad, the cuticular surface longitudinally striate, entirely ciliate; pharynx obconical, about one-third as long as the body, longitudinally plicate, the anterior orifice transversely oval; nucleus apparently subspherical or broadly oval, subcentrally located; contractile vesicles three or more, near the posterior extremity; anal aperture postero-terminal; endoplasm enclosing numerous, green corpuscles which obscure the internal structure, and render the body semi-opaque. Movements rotary on the longitudinal axis. Length of body, $\frac{1}{100}$ inch. *Hab.*—Pond water in early spring, from near Trenton, N. J.

This form differs from *E. farctus* C. & L., in the presence of the multiple contractile vesicles and in the single, rounded nucleus, the latter in *E. farctus* being recorded as band-shaped.

The infusorian was obtained in abundance in a gathering made in the middle of February in the mild winter of 1889–'90. Reproduction is by transverse fission.

*Nassula trichocystis*, sp. nov. (Fig. 11).—Body elongate-ovate or subelliptical, cylindrical, more than twice as long as broad, the two extremities subequal; oral aperture near the anterior extremity, in a slight depression or concavity of the lateral body-margin, and followed by a conspicuous, conical, pharyngeal rod-fascicle extending to near the body-centre; oral cilia somewhat larger and more conspicuous than those of the general surface; contractile vesicle single, spherical, laterally placed in the posterior part of the anterior body-half, often leaving small lacunæ at complete systole; nucleus subspherical, subcentrally located; trichocysts exceedingly abundant, obliquely and densely set within the cortical layer; endoplasm frequently exhibiting a movement of rotation. Length, $\frac{1}{575}$ inch. *Hab.*—Pond water, near Short Hills, N. J. Movements rotary on the longitudinal axis.

This form, which is interesting on account of the remarkable abundance of trichocysts enclosed by the cortex, was collected by Mr. H. C. Wells, of Short Hills, N. J., and by him sent to me.

*Urostyla vernalis*, sp. nov. (Fig. 12).—Body elongate-ovate, or subelliptical, soft and flexible, about three times as long as broad, both extremities rounded, the anterior somewhat curved towards the left-hand side and slightly narrowed; posterior extremity sometimes evenly convex, frequently obtusely pointed on the right-hand side of the median line; dorsal aspect convex, its cuticular surface irregularly roughened by clusters of minute, rounded elevations arranged in irregularly longitudinal series; lateral body-margins of the larger infusorians often flattened and subparallel, those of the smaller forms convex; upper lip crescentic; peristome field obovate, the anterior region of the adoral depression proper not including any portion of the frontal border, but taking its origin posteriorly to that margin, at a distance about equal to one-tenth the length of the entire body, and extending on the left-hand side of the body somewhat obliquely backward towards the right-hand side for about one-third the length of the ventral surface, its left-hand margin bearing a series of large and conspicuous adoral cilia, and a row of finer par-oral cilia, the right-hand border supporting an undulating membrane and a series of fine pre-oral cilia; endoral cilia none; uncinate frontal styles from four to six, distally bifid and somewhat irregularly placed near the right-hand border of the peristome field; ventral surface clothed by fine, vibratile cilia in six parallel, longitudinal lines; marginal setæ longest, largest and most conspicuous on the posterior border, where they are slightly interrupted, those on the two sides of the median line of the body usually directed towards one another and frequently overlapping; anal styles slender,

fimbriated, from six to eight in number, arranged in an oblique row and not projecting beyond the body-margin ; contractile vesicle single, spherical, near the left-hand side of the anterior body-half, in the dorsal aspect, the cuticular surface of which it elevates at its systole, and through which it seems to discharge its contents ; nucleus double, the two nodules ovate, one being in the anterior, the other in the posterior body-half, near the left-hand body-margin, and each bearing a laterally attached nucleolus ; anal aperture not observed. Length from $\frac{1}{150}$ to $\frac{1}{75}$ inch. *Hab.*—Shallow way-side pools in the early spring, near Trenton, N. J. Reproduction by transverse fission. Endoplasm brown.

This form bears a somewhat close resemblance to *Urostyla trichogaster* Stokes, but differs conspicuously in its habitat, *U. trichogaster* being found in infusions of decaying vegetable matters, the present species in the clear, pure waters of the pools of early spring. It also differs in the character of the adoral depression which does not include a part of the frontal border of the body ; in the absence of the endoral cilia, and especially in the fewer frontal styles.

The body is exceedingly soft and flexible, and its motions active. The brown endoplasm is often of a beautiful, transparent golden tint. The favorite food is the algal spores and the other small vegetal objects with which the shallow pools are at this time of the year so well supplied, while the food of *U. trichogaster* is chiefly animal.

*Acineta corrugata*, sp. nov. (Figs. 13, 14, 15).—Lorica ovate or subtriangular, compressed, the length but slightly exceeding the greatest breadth ; lateral margins convex, tapering towards the pedicle and variously crenated, or almost smooth and even ; general surface bearing numerous, irregularly disposed but frequently parallel and centrally converging, linear ridges, that vary in number, arrangement and general direction with the age of the lorica, in maturity and in old age the interlinear spaces becoming exceedingly prominent as inflated, rounded and elongated prominences, the lateral borders of the lorica then being conspicuously and irregularly crenate ; anterior margin slightly elevated centrally, this elevation extending perpendicularly along the subcentral region of the frontal and of the dorsal aspects of the sheath, this in transverse, subcentral optical section having a rhomboidal outline, the lateral borders truncate and emarginate ; anterior border of the lorica closed in except for a narrow, slit-like aperture traversing it, and an ovate orifice at each antero-lateral margin for the passage of the fasciculate, capitate tentacles ; frontal region, in surface view, compressed and undulate, or with six oppositely disposed, concave depressions ; pedicle conspicuous, well-developed, hollow and about one-third as long as the lorica ; nucleus apparently broadly ovate and subcentrally located ; endoplasm coarsely granular ; the enclosed animalcule usually nearly filling the cavity of the sheath. Length, including pedicle, $\frac{1}{150}$ inch. *Hab.*—Attached to filamentous algæ in the brackish water of a salt marsh, Coney Island, N. Y.

The corneous, transparent lorica is exceedingly thin and delicate, vary-

ing much in connection with the surface plications or ridge-like elevations, in early youth the raised lines being low, inconspicuous and irregularly disposed ; in maturity becoming full, rounded and prominent, separated by deep furrows, as if the wall of the lorica had become distended with liquid, dilatation taking place at expansile regions between the ridge-like markings of the earlier stage ; in the mature state the lateral borders are protuberantly crenate.

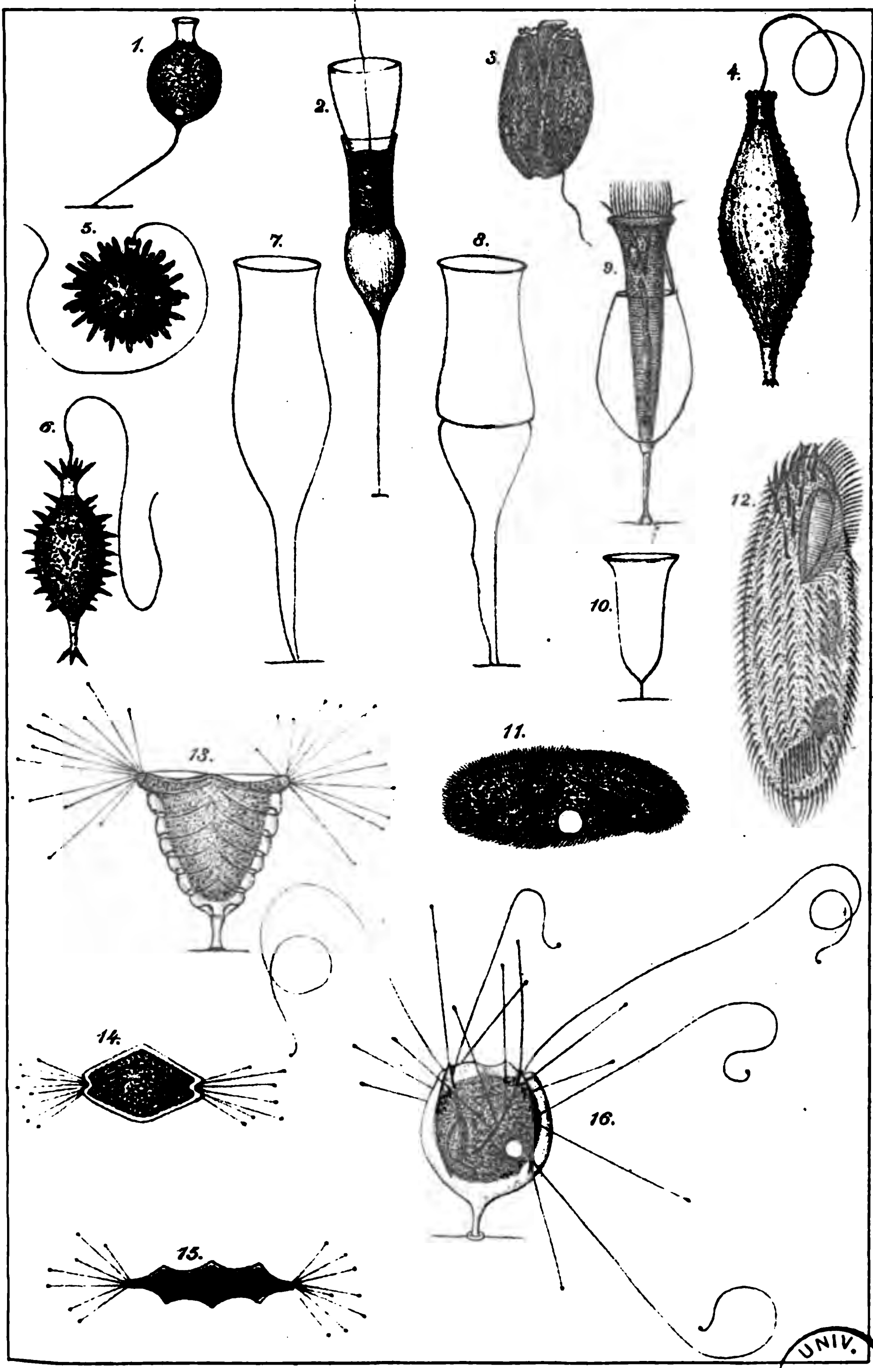
*Acineta flexilis*, sp. nov. (Fig. 16).—Lorica irregularly subspherical, tapering posteriorly to the short, hollow pedicle ; anterior border closed, thin, apparently perpendicularly lamelliform, the margin irregularly undulate ; two opposite lateral regions each bearing two anteriorly approximating, posteriorly diverging, narrow fissures for the passage of the tentacles, the fissures usually being open only sufficiently for the passage of the tentacles, except during the final development and the escape of the embryo, when those on the lateral margins and that on the frontal border are seen to be continuous, the expanding fissures closing after the escape of the embryo ; pedicle about one-seventh as long as the lorica ; tentacles capitate, of two kinds and apparently issuing only from the slit-like lateral fissures, one kind being straight, rigid, and not often exceeding twice the length of the lorica, the other form filamentous, flexible, writhing and variously curved and coiled, often extending to more than five times the length of the lorica ; body of the animalcule subspherical or obpyriform, not filling the cavity of the lorica, and in no way adherent to it ; endoplasm granular ; nucleus broadly ovate, located near one lateral border ; contractile vesicle single, spherical, postero-lateral in the region opposite the nucleus. Length of the lorica, including the pedicle, $\frac{1}{380}$ inch. *Hab.*—Fresh water from near Trenton, N. J.; attached to *Spirogyra*.

*Codosiga florea* Stokes (*Journ. Trenton Nat. Hist. Soc.*, January, 1888, Vol. i, No. 3).—This was incorrectly placed in the genus *Codosiga ;* it is a *Monosiga*, and should be referred to as *Monosiga florea.*

*Halsis furcata* Stokes (*Journ. Royal Micros. Soc.*, August, 1889).—This generic name being preoccupied, it may, in this instance, be changed to *Halsiopsis*, the single known species then being *Halsiopsis furcata.*

### Explanation of the Plate.

Fig. 1. Salpingœca globosa ; with collar retracted.
" 2. Salpingœca collaris.
" 3. Prorocentrum hamatum. × 720.
" 4. Trachelomonas fusiformis. × 500.
" 5. Trachelomonas sphærica. × 460.
" 6. Trachelomonas acanthophora. × 500.
" 7, 8. Vaginicola longipes. × 200.
" 9. Caulicola valvata. × 400.
" 10. Bicosœca phiala ; empty lorica. × 835.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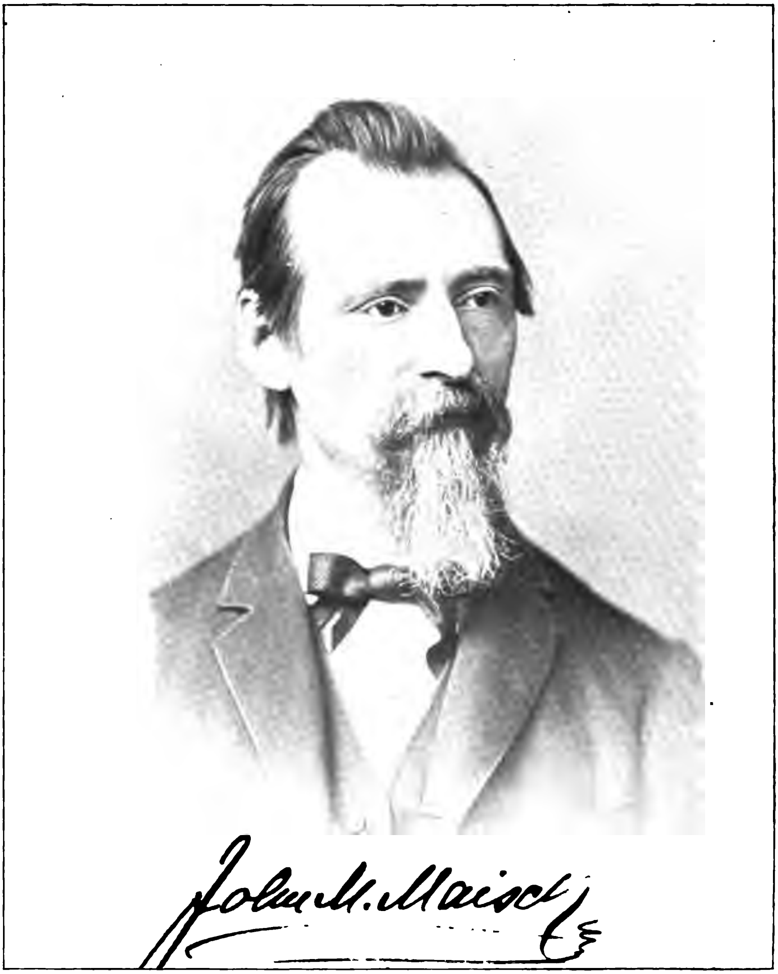
John M. Maisch

Fig. 11. Nassula trichocystis. × 450.
" 12. Urostyla vernalis. × 190.
" 13. Acineta corrugata ; mature, but not old, form. × 400.
" 14. Acineta corrugata ; transverse, subcentral, optical section. × 400.
" 15. Acineta corrugata ; surface view of the frontal region ; somewhat more enlarged than in Figs. 13, 14.
" 16. Acineta flexilis. × 560.

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## *Obituary Notice of John M. Maisch.*

*By Charles S. Dolley, M.D.*

*(Read before the American Philosophical Society, December 7, 1894.)*

The preëminence which American pharmacy has for many years maintained may without doubt be largely attributed to the scientific zeal and ability of the teachers of pharmaceutical science in the various institutions of the country. To no one belongs a greater meed of praise than to the late Prof. Maisch, a member of the American Philosophical Society, to which he was elected January 18, 1884.

John Michael Maisch was born of humble parents in Hanau on the Main, Germany, on the 3d of January, 1831. His early education was obtained at the free schools of his native town, and he soon attracted the special attention of his teachers on account of his aptness and diligence. Under one Theobald, he was introduced to the study of mineralogy and microscopy and began practical field work in the vicinity of Hanau, and it was largely due to the interest awakened by this teacher that he became ambitious for a university education and was led to seek instruction outside that afforded him by the curriculum of his school.

Under Dr. Bromies he soon demonstrated his fitness for original investigation in chemistry, and was permitted by him to assist in certain studies of the fatty acids and resins.

For a time his inclinations were towards theology, but his increasing interest in natural science led him to abandon the idea and to devote himself with such ardor to his scientific studies as to undermine his strength to such an extent that it became necessary not only to give up close application for a time, but, in the end, to relinquish his strong desire for a university course.

Entering the military service of Hesse, he became impregnated with the revolutionary ideas rife among the soldiery, and recognizing the inconsistency of his position, he resigned his post and, joining the Turners of

Hanau, accompanied them in their excursions through the Valley of the Main, assisting them in the promulgation of revolutionary sentiments.

In 1849, while engaged in this work, he was arrested at Sinsheim and sentenced to four and a half years' imprisonment with hard labor; but through the connivance of friends he soon after effected his escape and managed to emigrate to America. Landing almost penniless in Baltimore, young Maisch took up for a time with factory work, but soon managed through his fondness for natural science to make the acquaintance of Drs. Wiss and Vogler, who aided him in the study of pharmacy and gave him employment for a time during the years 1850–51 in a drug store owned by the former. This store being sold, Mr. Maisch removed to Washington, where he served in a drug store until 1853, when his parents and sisters having come to Philadelphia, he joined them there. For about two years he acted as drug clerk in Philadelphia and New York and finally entered a chemical factory in Brooklyn. From 1856 to 1859 he was employed by the firm of E. B. Garrigues and Robert Shoemaker, of Philadelphia, and in the latter year he accepted an instructor's position in the School of Pharmacy conducted by Prof. Parrish in an upper room at the southwest corner of Eighth and Arch streets.

Here his natural love for research, his tact and ability as a teacher attracted attention and led to his call to the Professorship of Pharmacy and Materia Medica in the College of Pharmacy of the City of New York, his spare time being employed in the laboratory of Dr. E. R. Squibb. Prof. Maisch returned to Philadelphia in 1863, when under Surgeon-General Hammond he organized the U. S. Army Laboratory, which, during the two and a half years in which he conducted it, is said to have effected a saving to the Government of nearly a million of dollars. After the War and until 1871 Prof. Maisch carried on a retail drug business at 1607 Ridge avenue, but finally gave it up on account of his increasing duties at the Philadelphia College of Pharmacy and as the Secretary of the American Pharmaceutical Association, of which he had been from 1856 one of the most active members.

It was in 1866 that John Maisch succeeded William Proctor, Jr., in the Chair of Pharmacy, but in the ensuing year he exchanged Chairs with Prof. Parrish, assuming the title of Professor of Materia Medica and Botany. This position Prof. Maisch retained until his death on the 10th of September, 1892. In 1860 he was elected a member of the Board of Trustees of the Philadelphia College of Pharmacy and ten years later accepted the editorship of the *American Journal of Pharmacy*. That John Maisch was a man of unwearied industry, absolute integrity and profound knowledge, is the unanimous testimony of all who were familiar with him and with his teachings and writings, a fact which was emphasized by the conference of the Hanbury Gold Medal upon him by the Pharmaceutical Society of Great Britain for distinguished services and original research in the natural history of drugs. The following is a list of Prof. Maisch's contributions to science :

1854. On the Adulteration of Drugs and Chemical Preparations. Amer. Journ. Pharm.
Liquor Ferri Iodide. *Ibid.*
1855. On the Incompatibility of Sulphate of Quinia with the Acetates. *Ibid.*
Examination of Bitartrate of Potassa. *Ibid.*
Effects of Sunlight on the Syrup of Iodide of Iron. *Ibid.*
Translation of M. Strecker's Paper on Quinine. *Ibid.*
Contributions to Toxicology. *Ibid.*
1856. On Convenient Modes of Administering Cod Liver Oil. *Ibid.*
On the Relations of Physicians and Pharmaceutists. *Ibid.*
Contributions to Toxicology. *Ibid.*
On an Expeditious Mode of Making Mercurial Ointment. *Ibid.*
On Solution of Gutta Percha. *Ibid.*
On Sulphate of Quinine and Carbonate of Ammonia in Pills. *Ibid.*
On Wine of Colchicum Seed. *Ibid.*
1857. On Protiodide of Mercury. *Ibid.*
On Effervescing Powders. *Ibid.*
Solubility of Iodides in Syrupus Ferri Iodidi. *Ibid.*
On Fluid Extract of Arnica. *Ibid.*
On Fluid Extract of *Uva ursi*. *Ibid.*
On the Detection of a New Falsification of Oil of Bitter Almonds. *Ibid.*
American Eclectic Resinoids. Buchner's Repertorium für Pharmacie, Vol. vi, p. 481.
1858. On the Sale of Poisons in the United States. *Ibid.*, Vol. vii, p. 267.
On Fluid Extracts in the United States. *Ibid.*, Vol. vii, p. 297.
Remarks on Some Pharmaceutical Preparations. Amer. Journ. Pharm.
On Diluted Acetic Acid. *Ibid.*
On the Preservation of Drugs from Insects. *Ibid.*
Note on Syrup of Hypophosphites. *Ibid.*
On the Decomposition of the Quinia by the Acetates. *Ibid.*
1859. On Extractum Ferri Pomatum. *Ibid.*
On the Preservation of Fluid Extracts. *Ibid.*
On the New System of German Weights. *Ibid.*
On the Proper Menstruum for Fluid Extracts. *Ibid.*
Notes on Fluid Extracts of Buchu, Cimicifuga, Serpentaria and Valerian. *Ibid.*
On the Solubility of Phosphate of Iron. *Ibid.*
On a New Mode of Preparing Some Syrups. *Ibid.*
Manufacturing Pharmacy in the United States. Buchner's Repertorium, Vol. viii, p. 433.
1860. On Examination of Oil of Peppermint. Amer. Journ. Pharm.
On Some Preparations of Calamus Root. *Ibid.*
Gleanings from the German Journals (three articles). *Ibid.*

1860. Alumen Exsiccatum. *Ibid.*
Analysis of Commercial Glacial Phosphoric Acid. *Ibid.*
Note on Benzoic Acid and Some Benzoates. *Ibid.*
On the Detection of Croton Oil in Mixtures. *Ibid.*
Analysis of Milk. *Ibid.*
Chemical Notes. *Ibid.*
Alumen ustum. Buchner's Repertorium, Vol. ix, p. 127.
United States Pharmacy. *Ibid.*, p. 145.
1861. On *Chelidonium majus.* Amer. Journ. Pharm.
On the Adulteration of Carmine. *Ibid.*
On Commercial Iron by Hydrogen. *Ibid.*
On the Importation of Mineral Waters. *Ibid.*
Analysis of the Chalybeate Waters of Sharon Spring, New York. *Ibid.*
On Anacahinte Wood. *Ibid.*
On the Tincture and Ferrated Tincture of Bark. *Ibid.*
On the Origin of Bay Rum. *Ibid.*
On the Volatile Oil of *Myrcia acris.* *Ibid.*
On the Ferrated Tincture of Cinchona. *Ibid.*
On the Conversion of Monohydrated into Common Phosphoric Acid. *Ibid.*
Gleanings from the German Journals (four articles). *Ibid.*
Chemical Examination of Cocoa Leaves. *Ibid.*
On the Mineral Water Trade in the United States. Buchner's Repertorium, Vol. x, p. 257.
On the Medical Flora of the Vicinity of Philadelphia. *Ibid.*, Vol. x, pp. 289 and 359.
1862. Gleanings from the German Journals. Amer. Journ. Pharm.
On Commercial Belladonna Leaves. *Ibid.*
Report of Committee on Herbarium. *Ibid.*
On the Standing of the Pharmacist in the United States Army. Buchner's Repertorium, Vol. xi, p. 294.
On Snake-bite Remedies in the United States. *Ibid.*, p. 352.
1863. On Copaiba Pills. Amer. Journ. Pharm.
Gleanings from the German Journals. *Ibid.*
Note on the Alkaloids of *Menispernum Canadense.* *Ibid.*
Note on Podophyllum. *Ibid.*
1864. Practical and Scientific Notes. *Ibid.*
On Impurities and Adulterations. *Ibid.*
Gleanings from German Journals. *Ibid.*
On the Contamination of American Sulphuric Acid with Arsenic. *Ibid.*
1865. On the Preparation of Heavy Oil of Wine. *Ibid.*
1866. On the Active Principle of Rhus Toxicodendron. *Ibid.*
1867. On Liquor Magnesiæ Citratis. *Ibid.*
On Liquor Ferri Acetatis. *Ibid.*

1867. On the Specific Gravity of Medicinal Chloroform. *Ibid.*
On Colchicia. *Ibid.*
On Tests for the Purity of Glycerin. *Ibid.*
On Carelessness in the Collection of Drugs. *Ibid.*
Note on Cheap Glycerin. *Ibid.*
Gleanings from the German Journals (two articles). *Ibid.*
On a Permanent Solution of Pyrophosphites of Soda and Iron. *Ibid.*
Review of Pharmacopœia Helvetica. *Ibid.*
1868. Gleanings from the German Journals. *Ibid.*
On Chloroform. *Ibid.*
Note to Editor on False Jalap. *Ibid.*
1869. Gleanings from the German Journals (four articles). *Ibid.*
On the Milky Juice of *Lactuca elongata*. *Ibid.*
On Some Panama Drugs. *Ibid.*
On the Nomenclature and Definitions of the United States Pharmacopœia. *Ibid.*
1870. On *Lycopodium clavatum*. *Ibid.*
On the Weeds of Western Peppermint Plantations. *Ibid.*
Gleanings (three articles). *Ibid.*
On Pharmaceutical Legislation. *Ibid.*
On Solubility of Glue in Glycerin. *Ibid.*
1871. Decomposition of Acetate of Morphia in Aqueous Solution. *Ibid.*
Detection of Turmeric in Powd. Rhubarb and Mustard. *Ibid.*
Ferrated Elixir of Cinchona. *Ibid.*
Gleanings from Foreign Journals. *Ibid.*
Gleanings from German Journals (four articles). *Ibid.*
Fluid Extract of Chestnut Leaves. *Ibid.*
Note on Amylo-nitrous Ether. *Ibid.*
Note on Hydrocyanate of Morphia. *Ibid.*
Note on Some Pill Masses. *Ibid.*
Precipitation of Quinia by Iodide of Potassium. *Ibid.*
Seeds of Two Species of Strychnos. *Ibid.*
Solutions of Alkaloids in Medicated Waters. *Ibid.*
Syrupus Assafœtidæ. *Ibid.*
1872. Gleanings from the European Journals (twelve articles). *Ibid.*
Loss of the Herbaceous Parts of Plants in Drying. *Ibid.*
Monobromated Camphor. *Ibid.*
On an Asserted Specific for Ague. *Ibid.*
On Some Pectoral Powders of European Pharmacy. *Ibid.*
On the Botanical Origin of Root of Cypripedium. *Ibid.*
On the So-called African Saffron. *Ibid.*
Pharmacognostical Notes. *Ibid.*
Use of Petroleum Benzine in Making Oleoresins. *Ibid.*
1873. Chloride of Mercurethyl. *Ibid.*
Impurities Among Rhizomes of Cypripedium. *Ibid.*
Levico Mineral Water. *Ibid.*

1873. Gleanings from European Journals. *Ibid.*
Medicinal Use of Green Soap. *Ibid.*
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# *The Château de Rochambeau.*

*By Joseph G. Rosengarten.*

*(Read before the American Philosophical Society, December 21, 1894.)*

The home of La Fayette at La Grange has long been a point of attraction for many Americans, full of admiration for La Fayette and the part he played in the American Revolution. The story of his services in behalf of the struggling colonies, so well told by Mr. Charlemagne Tower, Jr., in his noteworthy contribution to our history of the Revolution, will undoubtedly strengthen and renew the strong affection always entertained in this country for La Fayette, so markedly exhibited during his lifetime, especially on his last visit to this country, and in the reception given to his descendants, who came here to join in the celebration of the centennial anniversary of the surrender of Cornwallis at Yorktown. In doing honor to La Fayette and to his countrymen for their help in securing American independence, we ought not to forget the Rochambeaus, father and son, the former the General-in-Chief of the French Allied Army sent to help the American colonies in their struggle against Great Britain, the son his Aid de-camp, who served with distinction, and was sent to France to secure that final help, fleet, men and money, with which the long war for Independence was brought to a successful termination by the closing and crowning victory. A recent visit to the Château de Rochambeau showed that it was full of interest for Americans, for there the present owner, the Marquis de Rochambeau, piously preserves the historical relics of the family, and prominent among them are those that marked the Comte de Rochambeau's leading part in the American War of Independence. The Château itself is of great interest. Situated on the banks of the Loire, between Blois and Vendôme, it is easily accessible, and a view of its fine grounds, its curious caves, its lovely outlook over the valley of the Loire, its noble avenue and the beautiful river, is of itself a delight to lovers of the picturesque.

In the Massachusetts Historical Society *Proceedings*, 1882–83, Vol. xx, p. 100, the late Hon. Robert C. Winthrop describes his then recent visit to the Château de Rochambeau, where he found many relics of the old Marquis and Count, as he then was, of Yorktown memory—the sword which he wore in America, his badge as an honorary member of the Cincinnati, his baton as a Marshal of France, with all his orders and decorations, and a portrait of himself, one of a large series of family portraits on the walls. On pedestals in the corners were two beautifully wrought miniature cannon, inscribed as having been presented to the widow of the old Marquis by Louis XVIII, to take the place of the two British cannon which Washington had presented to Rochambeau after the victory at Yorktown, which had been seized and probably recast during the French Revolution. In his bedroom was the original MS. of his *Memoirs* printed in

1809. Between the windows was a large portrait, one of Peale's original portraits of Washington, which had been presented by Washington himself to Rochambeau—a large square or three-quarters portrait, in military costume, with a cannon and other military emblems in the background—in perfect preservation and worthy of being included among the most notable of the numberless portraits of the Father of his Country.

A recent visitor, giving an account of the Château as he saw it in September last, in a letter printed in the Philadelphia *Ledger* of October 31, 1894, speaks of the fine suits of ancestral armor, worn by the Rochambeaus of the sixteenth century, around which are draped the American flags, presented by Gen. Hancock to the present owner, certainly an involuntary tribute by the *preux chevalier* of our own army to the prowess of these knights of old. He also was among those who on behalf of the Government of the United States welcomed the Marquis de Rochambeau as the leader of the French visitors of 1881, descendants of the gallant soldiers who had shared in the honors of the surrender at Yorktown. Thus the connection between the Rochambeau of our own Revolutionary War, and the Rochambeau of to-day, is one of the pleasant ties that keep alive the friendship of the two countries and make the United States and France sister republics. The Comte de Rochambeau left two volumes of *Memoirs*, published in Paris in 1809, edited by Leonce de Lancival, which tell the story of his life. Born at Vendôme July 1, 1725, and dying at the Château de Rochambeau on May 1, 1807, his long life was full of interesting experiences as a soldier, and the short episode of his services as Commander-in-Chief of the French Army sent to help Washington, is of itself enough to make him a man of note for all students of American history. He entered the French Army as Cornet in 1748, in Saint Simon's Regiment of Cavalry, and served with distinction in campaigns in Bohemia, Bavaria and on the Rhine ; he was made Colonel in 1767, as a reward for his brilliant services at the siege of Namur, and Brigadier for his action at Minorca, and Major-General for his reorganization of the French Army. He served under Marshals Saxe and Richelieu and d'Estrée and de Broglie, who afterwards sent De Kalb to this country with an offer to become the General-in-Chief of the army in the impending struggle, a curious episode admirably told by Dr. Stille, the President of the Historical Society of Pennsylvania. Rochambeau himself tells us that "after the peace," it must have been about 1769, when he was stationed at Strasburg as Inspector of the French Infantry in Alsace, he advised the Hereditary Prince of Brunswick to go to America, and there play the part of William of Orange in England—make himself sovereign of a superb empire—but the Prince had no idea that the colonies could be united then, or for a long time to come. It was a curious coincidence that he should have served under Marechal de Broglie, who seriously hoped to play a leading part in America, and that Rochambeau himself should have led the French Army which did such signal service in helping America to achieve its independence, while the same Brunswick

Prince sent his soldiers, in the pay of Great Britain, to help prevent the colonies from establishing their independence. Rochambeau was a soldier, and he had no political aims and ambitions either here or at home. After his brilliant career in the French wars on the Continent, he gained fresh honor by his successful reorganization of the French Army in its short experience of peace, and as Governor of the Department of Normandy and Brittany, and as Inspector-General, showed great capacity. In 1778 he organized the force intended for a descent on the English coast, and after twenty years of hard service was made Lieutenant-General. He was appointed to the command of the corps intended to be sent to America, consisting of 4000 men, seven ships, and money and supplies for the struggling colonies—De Ternay was put in command of the naval force. Arrived at Newport, R. I., after a voyage of seventy days, he disembarked with his contingent, fortified his position, and later on met Washington at Hartford, and arranged the plan of the campaign that was to end with such signal honor. He sent his son and Aid-de-camp back to France, to procure additional men, and further needed help, and through the younger Rochambeau's vigorous presentation of the case, France was led to send more ships and more men and more money. Col. de Rochambeau returned in May with the satisfactory news of another fleet under De Grasse and six hundred more soldiers and a million and a half francs in coin. Colonial bills were then selling at forty per cent. discount, and much benefit was derived from a further sum of six million francs, which was put at Washington's disposition. The French War Office advised a movement northward to the Penobscot, Nova Scotia and Halifax, but fortunately and wisely left Rochambeau free to join and act with Washington, and it was he who suggested the movement to and operations in Virginia, and at the same time asked for more ships and men and money from the French forces serving in the West Indies.

The Continental currency was practically repudiated by Congress. On June 18, the French corps started to join Washington's Army on the Hudson, making in all a force of 9000 men, enough to keep Clinton in New York and bring Cornwallis to the coast. De Grasse brought from San Domingo Saint Simon's corps of 3000 men and 1,200,000 francs.

Rochambeau divided the 100,000 Louis d'or in his army chest with Washington. The united army crossed the Hudson at King's Ferry, Washington leaving 3000 men on the left bank to cover West Point, the French taking position on the lower Hudson, as if for an attack on New York, but soon moving to the Delaware, passing it at Trenton, going through Philadelphia, where Congress reviewed it.

The library of the Historical Society has a copy of a rare book, an abridged translation of the *Memoirs of the Marshal Count de Rochambeau*, by M. W. E. Wright, published in Paris in 1838, giving that part of the French original dealing with his American campaigns. The English of this translation and the queer mistakes in names of men and places make this a very curious performance ; it does not seem to have invited any

attention to Rochambeau's *Memoirs* or to the broader subject of the French forces in America, since then so fully and ably discussed by the late Mr. Balch in his various elaborate studies of the material he gathered in Paris. In that treasure house of information on the subject, Doniol's *Histoire de la Participation de la France à l'Etablissement des États Unis d'Amerique*, Rochambeau's name and deeds are frequently recorded. Chosen to command a descent on the English coast, for his services in the Seven Years' War had made him preëminent for an independent expedition, he was suddenly called from the Château de Rochambeau, where he had just gone to take possession on the death of his father. He was assigned to the leadership of the force sent to America. He was in consultation with La Fayette as to its details. His instructions are printed in the seventh volume of Sparks' *Washington*, where the letters from Washington to Rochambeau, both in this country and after his return to Europe, show the close ties that bound the two in life-long friendship. La Fayette was full of zeal and ambition, and acting as intermediary between Washington and Rochambeau, was at the outset unwilling to defer to the prudence and experience of the elder soldier, but in the end all worked together harmoniously with the best results. Rochambeau treated La Fayette with fraternal tenderness, and even in criticising his impetuous plans, spoke of himself as "le vieux père qui parle à son cher fils." When Washington and Rochambeau met for the first time at Hartford, the former had Knox and La Fayette with him; the latter Ternay, Chastellux, Fersen, Damas, Mathieu Dumas. The results of the interview were entrusted to the younger Rochambeau, who sailed in a ship commanded by La Perouse, to seek in France additional help, men, money and ships. Chastellux and Mathieu Dumas both printed their accounts of their life in America, the former in 1786, the latter not until 1839, but both show that France and indeed all Europe were closely following events in America. Washington naturally deferred to the older soldier, but Rochambeau loyally sought to do all he could to assist both in perfecting plans for military operations and in making them successful by the prompt use of all the means at hand. The fifth volume of Doniol gives the letters of Rochambeau to the French War Department, from his accepting the command until he returned to France; it includes copies of his correspondence with Washington and with de La Luzerne, the French Minister in Philadelphia. In his letter accepting his appointment, he recalls his experience in the battles of Laufeldt, Crefeld and Clostercamp, and his reasons for a force large enough for all the contingencies of a war in a distant country. Undoubtedly to him is due the fact of later reinforcements of men and ships as well as liberal advances of money. Besides reproducing portraits of Rochambeau from Trumbull, Doniol gives in his fifth volume a portrait owned by the family, from a miniature in their possession. Of the son I know of no portrait in this country, although there is a very good one at the Château de Rochambeau, that might with advantage be reproduced to add to the growing gallery of men of note in our history.

In Scharf and Westcott's *History of Philadelphia*, Vol. i, p. 414, there is a record of the visit on August 30, 1781, of Washington and Rochambeau. They were received by the Light Horse and escorted to the city tavern and thence to the house of Robert Morris, on Market street, between Fifth and Sixth. At three o'clock they proceeded to the State House, and paid their respects to Congress, after which they returned to Mr. Morris', where they dined in company with Samuel Huntingdon, the President of Congress, Gens. Knox, Moultrie and other distinguished officers. In the evening the city was illuminated.

Mr. Westcott, in his *History of Philadelphia*, says that they dined with the President of Congress [of the State ?], Thomas McKean. In the afternoon the vessels in the Delaware displayed their flags and fired salutes. On September 3 and 4, the French Army marched through the city. Their route was down Front and Second street, and past the State House, where Thomas McKean, as President of the United States, being Chief Officer of Congress, dressed in black velvet, and sword by his side, his head covered, reviewed them, receiving the honors due to a sovereign. On his left were Washington and Rochambeau, uncovered, and on his right the Chevalier de la Luzerne, the French Minister. After the ceremonies, President McKean sent a formal letter to Count Rochambeau, expressing the satisfaction of himself and of Congress at the brilliant appearance and exact discipline of the several corps.

The regiment Soissonais was exercised on the commons on September 4, in the presence of Congress, the French Minister and the Generals, and 20,000 spectators. The regiment had four field pieces, and went through all the evolutions of a skirmish, to the delight and satisfaction of the vast crowd. On July 15, 1782, Washington and Rochambeau attended the fête given by the French Minister at his residence in Philadelphia to 1500 guests, in honor of the birthday of the Dauphin of France. His house was near Sixth and Chestnut streets, where in the evening there were fireworks on the large lot on Chestnut street opposite the Minister's residence. Mr. Gérard was elected a member of the Philosophical Society in 1779, following other illustrious Frenchmen on its rolls, Condorcet, Daubenton, Barbeu Dubourg, Le Roux, Reynall, Lavoisier, Rozier, and in turn followed by Luzerne, Marbois, La Fayette, Chastellux, Vergennes, Guichen, Rochefoucauld, Cabanis, Brissot de Warville, Du Pont de Nemours, and all of these have made their mark on both sides the ocean. Thus the Philosophical Society began its admirable method of recognition of those who have rendered great public service both in the old world and in the new.

Washington and La Fayette reached Williamsburg September 14, and found there La Fayette strongly posted. Barras brought the siege guns by water, and then took Viomesnil and his troops from Annapolis to Jamestown, where the whole army was united by September 26. On the 28th the siege of Yorktown was begun, de Grasse landing 600 men from his fleet to assist the land operations. The American Army was on the

right, the French on the centre and left. On October 19, Cornwallis surrendered with 8000 men, 214 guns and 22 flags. On the 27th an English fleet of 27 sail came to Cape Henry, but it was too late. The French took possession of the British quarters at Yorktown, Gloucester, Hampton and Williamsburg. Later they rejoined Washington at King's Ferry on the Hudson. Returning to France, Rochambeau was received with honor by the King, and, with other French officers who had served with him, was meted out decorations and promotions. It was on his return from Yorktown that here in Philadelphia, as he tells us in his *Memoirs*, of all the honors paid him, none touched him more than an address presented to him by a deputation of Quakers, old men in costumes that he characterizes as quaint from their simplicity, who thanked him, not for his military success, of which they told him they had no admiration, but because of his being the friend of mankind, and for the perfect order and discipline of his soldiers, and he records with satisfaction the fact that in the three campaigns he had made in America, there was not a single instance of any quarrel between soldiers of the French Army and those of the American Army, a record honorable alike to the soldiers of both nationalities, officers and enlisted men, too. It is eminently characteristic of the man that in this hour of glory he interceded on behalf of De Grasse and secured for him a return to the King's favor.

Rochambeau in his *Memoirs* gives a glowing account of the resources of the country, and says he thought the United States could some day have a population of thirty millions or more. He made a short visit to England and was received most cordially, meeting many of Cornwallis' officers on a very friendly footing. At the outbreak of the French Revolution he had both civil and military duties forced on him, and was given the command of the Army of the North. He was the last Marshal of France appointed by Louis the XVI, and Napoleon in confirming this distinction put him first on the list of his Marshals. Forced by ill health to give up his command, he retired to his Château, was arrested and sent to prison by Robespierre, and after nine months' confinement, barely escaping the guillotine, was released without trial, and indeed without formal charges of any kind. His son was sent to the West Indies, where he was as successful as possible under the most disadvantageous conditions, but finally was made a prisoner of war by the English. Paroled by them, he paid a visit to Washington, and was received by him with every honor. After eighteen months he was exchanged, and that for Gen. O'Hara, one of the English officers captured at Yorktown. He again returned to France, and was appointed Governor-General of San Domingo. The father congratulated Berthier, who had served under him in America, on his appointment as Napoleon's Chief of Staff, and was presented to Napoleon, who wanted to make him a senator, an honor which he declined on the score of age and bad health, but he was made Grand Officer of the Legion of Honor. The son was sent back to France as a prisoner by his own rebellious subordinates, and the father went to Paris to defend him against charges

made by his enemies, but the son was again a prisoner in England, in spite of the father's appeal to Cornwallis to remember his release on parole at Yorktown. The younger Rochambeau finally returned to France, was made General of Division, and lost his life at the battle of Leipsic, in 1813. The father had died in 1807, and a grandson, a young cavalry officer of great promise, praised by Davoust and promoted to a staff position, lost his leg in the same engagement, and was thus compelled to return to civil life. He lived and died at Rochambeau, and the stately Château is rich in relics of these three generations of gallant soldiers and of many ancestors of distinction in both civil and military life. The present Marquis de Rochambeau, himself no mean scholar in history and archeology, has printed an interesting little volume of sketches written by the younger General de Rochambeau during the last years of the eighteenth century, and when he was a prisoner of war in England between 1803 and 1811 ; they are drawn from his personal knowledge of the men and events hastily described—Danton, Robespierre, Barrère, Carnot, Brissot, Montesquieu, Custines, Biron, Pichegru, among them not a few who had served with the French Army in the American War of Independence, and some of whom achieved great distinction under Napoleon. It is curious to find that Gen. de Rochambeau suggests that the Duke of Kent be sent to command in Nova Scotia, in the hope that the dissatisfied party in the United States might find in him a possible candidate for President, making the office hereditary. As the elder Rochambeau had suggested to a Brunswick Prince the possibility of founding an empire in America, so the younger Rochambeau believed that the English Government had an idea that Americans still cherished a secret affection for the house of Hanover.

The Marquis de Rochambeau has printed, too, several valuable archeological works and an account of the Château de Rochambeau. He calls attention to the curious rock grottoes on the hillsides around it, the work of more than twenty centuries back, for he traces them to the Celts, and has found evidences of their handiwork, ancient dwelling places of the very earliest dwellers in the region, and their burial places, too, for skeletons of great antiquity, and other evidences of Druidical worship of the third century, have been found there. The estates were in the family from the eleventh to the twelfth century, and the deeds and other muniments of title have been preserved from the fifteenth century, beginning in 1486, although members of the family are known to have taken part in the Crusades, one of them under St. Louis of France falling in battle in Egypt in 1251, while another in return for his services in a campaign in Italy was granted as motto for his shield the device : "*Vivre en preux y mourir.*"

From 1516 the Château and estate of Rochambeau gave the name borne by the family, and among them some were distinguished in the wars of the League, others in the navy, one under Jean Bart was made Commodore in 1741, and another Governor of Vendôme was succeeded in that office

by his son, who commanded the French forces in the American War of Independence, and later on became Marshal of France. The Château itself dates from the twelfth or thirteenth century. It was originally surrounded by walls and flanked with towers. It was rebuilt by Marshal de Rochambeau in the style of his time, and all that recalled the feudal castle disappeared to make room for the architecture of the period. The towers were demolished, but so solid were the foundations that even now when the water of the Loire is clear the old massive stones on which they rested can be seen. Now the Château is a large main central building with two wings. These are comparatively modern, but the main body is of very old construction, with massive walls, secret passages and a hidden entrance to what were once the dungeon keep and underground prisons. In face of the main entrance a graceful modern chapel has been constructed, hollowed out of the soft rock. On one side a great series of stables and other houses, on the other the long line of very ancient caves, still used for farm purposes, in which the archeological zeal and intelligence of the present owner have unearthed many curious relics of its successive occupants, from those of the stone age, through Gallic and Roman days down to historic periods quite within our own memory. Indeed so vast are these artificial caves, that in one of the largest, a whole troop of cavalry were quartered during the recent French military manœuvres at Châteaudun, horses and men numbering nearly a hundred each, being easily accommodated in these roomy, high, airy, dry, well-lighted and well-ventilated natural dwellings. Where once the crenelated walls of the Château commanded the Loire, there are now broad terraces and flights of steps and grassy banks leading to the edge of the river; on either side of the Château fine gardens, and beyond the river broad meadows planted with fine trees in the style of an English park, so much affected in France in the last century, while a splendid avenue of a mile or two leads from the house between the river on one side and the series of rock caves on the other, to the high road leading to Vendôme, all in admirable preservation, and in striking contrast to the flat plain that surrounds the famous Château de Chambord, and the typical straight lines of small trees that are so frequent throughout Touraine, depriving even its historical châteaux of the beauty of the simple Château de Rochambeau. The present Marquis de Rochambeau, in his interesting monograph on the Château and its vicinity, gives a series of early charters, from the seventh to the thirteenth century, for churches and properties now included in its grounds, and the gift of the ground itself under the name of Rochambeau in 1486, the will of the first owner of the present family in 1598, the deed of the establishment of its chapel in 1633, and other interesting papers drawn from the family archives and from local and other public depositories of ancient records. These monographs, that of the younger General de Rochambeau, and that of the present owner of the Château, are in the library of the Historical Society of Pennsylvania, which already has on its shelves the *Memoirs* of the Count de Rochambeau,

the Commander of the French Allied Troops in the War of American Independence, and the archeological writings of the present owner are in the library of the American Philosophical Society. I am very sure that the present owners of the Château will be glad to know that the name of Rochambeau is still borne in honor and affection in this country. The official papers of Rochambeau as Commander of the French Army in this country have very properly been obtained by the Government of the United States, and are now safely deposited in Washington, where no doubt they will be made accessible to students of American history. His private papers are still preserved in the family Château, where he lived and died, and it would be very interesting if his correspondence with those he left there, during his service in this country, could be made public, for we should have from a man of large experience his judgment and opinions of the American patriots and statesmen and soldiers with whom he was in daily communication, and we should know how this old French nobleman and soldier was impressed by the country and the people. His printed *Memoirs* are very favorable in every thing he says of the country and of its people, but they deal in generalities after the fashion of the day. No doubt they give rather his general impressions as he transmitted them by word of mouth to a literary man, who really edited them to suit his own views of how biography ought to be written, than with any fidelity to the plain speech of the old soldier, whose experiences in a long life must have been so wide and so varied. No doubt, too, after the rough usage of the French Revolution, with actual imprisonment and the threat of the guillotine, he looked back on his stay in America, at the head of a well-disciplined and well-equipped force of old soldiers, surrounded by officers who represented the flower of the French aristocracy in its best estate, as a period of great expectations, more than realized by the prosperity of the infant Republic, in great contrast to the violent changes in France, the sad days of the declining monarchy, its violent overthrow, the stormy days of the French Revolution, its excesses, and the strong measures by which Napoleon reëstablished the heavy hand of military power in France and over Europe, and the brilliant years of his empire after its first proclamation. When the elder Rochambeau died, Napoleon was at the very zenith of his power, and when the younger Rochambeau fell at Leipsic, Napoleon's star was still in the ascendant. It would be most gratifying to learn whether their private correspondence and family and other papers are still preserved, and to have them printed, if not in full, at least at sufficient length to give to the growing army of American historical students a better knowledge of the Rochambeaus as they lived and thought, and of their opinions of the men of the new country to whose future greatness they had contributed so largely. That they came of old historic and military stock, tracing its home back to Celtic days, and their family to ancestral Crusaders, made them all the more helpful for the Republic of the New World.

*Stated Meeting, November 2, 1894.*

President, Mr. FRALEY, in the Chair.

Correspondence was submitted as follows:

A circular from the Executive Committee in honor of Prof. Guido Cora, Turin, Italy, requesting contributions for his twenty-fifth anniversary.

The following societies were reported as having been placed on the list to receive the Society's Proceedings: Societé Française de Physique, Redaction de la Melusine, Paris, France; Società Toscana di Scienze Naturali, Il Nuovo Cimento, Pisa, Italy; American Academy of Medicine, Easton, Pa.; American Archæological and Asiatic Association, Nevada, Ia.; Iowa Masonic Library, Cedar Rapids, Ia.; Field Columbian Museum, Chicago, Ill.; University of Wisconsin, Madison, Wis.; Historical Society of Southern California, Los Angeles, Cal.; California Historical Society, San Francisco, Cal.; Associacion de Ingeneiros y Arquitectos de México, Mexico; Observatorio Meteorológico Central, Xalapa, Mexico.

Accessions to the Library were reported from the Government Geologist, Adelaide, Australia; Congrès Internationaux, Moscow, Russia; Finska Litteratur-Sällskapet, Helsingfors, Finland; R. Societatis Scientiarum, Upsal, Sweden; R. Académie des Sciences, Amsterdam, Netherlands; Mittelschweizerische Geographisch-Kommerzielle Gesellschaft, Aarau, Switzerland; Société Fribourgeoise des Sciences Naturelles, Fribourg, Switzerland; K. K. Militär-Geographisches Institut, Vienna, Austria; Centralbureau der Internationale Erdmessung, K. P. Geodätische Institut, Berlin, Prussia; Naturforschende Gesellschaft, Emden, Prussia; Senckenbergische Naturforschende Gesellschaft, Frankfurt-am-Main, Germany; Naturhistorische Gesellschaft, Nürnberg, Bavaria; Verein für Vaterländische Naturkunde in Würtemberg, Stuttgart; Ministère des Travaux Publics, Paris, France; Cobden Club, London, England; Islenzka Fornleif af jelags, Reykjavik; Agricultural Experiment Station, Burlington, Vt.; Society of Natural History,

Boston, Mass.; N. H. Colony Historical Society, New Haven, Conn.; Society of Natural Sciences, Buffalo, N. Y.; Geological Survey of Pennsylvania, Dr. Bushrod W. James, Messrs. B. S. Lyman, MacCalla & Company, Philadelphia; Commissâo Geographica e Geologica, San Paulo, Brazil.

The following decease of members was announced:

Prof. J. A. Froude, London, England, October 20, 1894, æt. 77.

Col. Garrick Mallery, Jr., Washington, D. C., October 25, 1894, æt. 63.

Dr. William Goodell, Philadelphia, October 27, 1894, æt. 65.

On motion the President was authorized to appoint at his leisure a suitable person to prepare the obituary notice of Dr. Goodell.

The consideration of the amendments to the Laws, postponed from the last meeting, came up as the stated business of the Society.

On motion, the consideration of the pending amendments was resumed.

Dr. Greene moved that the further consideration of Articles 1–5 inclusive, Chapter I, be indefinitely postponed, which motion was carried, ayes 16, nays 7.

Sections 6 and 7, Chapter I, were put to a vote and carried as follows:

Section 6. Such members as reside within *thirty* miles of the hall of the Society, and such other members as desire to vote at the meetings and elections, shall pay an admission fee of ten dollars, and annually thereafter, on the first Friday of January, a contribution of five dollars. The payment of *one hundred dollars* at one time, by a member not in arrears, shall exempt him from all future annual payments.

Section 7. Members-elect, residing within thirty miles of the hall, shall lose the right of membership unless they subscribe the Laws and pay their admission fee within one year after their election. Any member liable to an annual contribution, who shall neglect or refuse to pay the same for the term of two years, shall be notified by the Treasurer in writing, on or before the second Friday in January after such default, that his rights as a member are suspended; and, in case the said arrears, together with the contribution due on the first Friday in January after such notice, shall not be paid to the Treasurer on or before the said last-named day, the membership of such defaulting member shall be forfeited,

his name stricken from the roll, and reported to the Society by the Treasurer.

On motion, Section 5, Chapter II, of the amendments was indefinitely postponed.

The amendments to Chapter VIII as to the Library and the Librarian were referred to the Library Committee.

Chapter IX, Section 3, was amended and carried as follows:

SECTION 3. *Twenty* qualified voters present at any stated or special meeting shall be a quorum, and be competent to elect members, dispose of property, appropriate money, and award premiums; but no property shall be alienated or encumbered, except by the vote of three-fourths of the qualified voters present, and given at two successive stated meetings. For the transaction of the ordinary business, the reception and reference of communications on literary, scientific or other subjects, the members present shall be deemed competent to act, and, in the absence of qualified voters, shall form a quorum.

Chapter VII, Section 7, was amended and carried as follows:

SECTION 7. The President and Senior Secretary of the Society shall be, *ex-officio*, the President and Clerk at their meetings; and *seven* of their number shall be a quorum.

It was ordered that consideration of the above amendments be made the stated business of the ensuing meeting, copies of the amended regulations to be sent to the members with the meeting notices, with notice that the same will then come up for final adoption.

Mr. Benjamin Smith Lyman read a paper on "Some Coal Measure Sections near Peytona, West Virginia."

Prof. Barker presented a paper entitled "The Atomic Mass of Tungsten," by Prof. Edgar F. Smith and E. D. Desi; also one on "The Atomic Mass of Tungsten," by Prof. Edgar F. Smith and Mary E. Pennington.

Dr. Alfred C. Stokes presented (through the Secretaries) a paper entitled, "Notices of Presumably Undescribed Infusoria."

On motion of Dr. Greene, it was

*Resolved*, A Committee of three be appointed to consider the expediency of providing a light collation after each stated meeting of the Society, or at stated intervals, in the Society's rooms, and that the Committee be

given power to act provided no expense be incurred by the Society by such action.

And the Society was adjourned by the President.

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*Stated Meeting, November 16, 1894.*

President, Mr. FRALEY, in the Chair.

Correspondence was submitted as follows:

An invitation from the Gesellschaft für Anthropologie, Ethnologie und Urgeschichte, Berlin, Prussia, to attend the twenty-fifth anniversary of its foundation, November 17, 1894.

Letters of envoy were received from the Royal Academy of Sciences, Amsterdam, Netherlands; K. Geologische Landesanstalt und Bergakademie, Berlin, Prussia; R. Instituto di Studi Superiori, Firinze, Italia; Muséum d'Histoire Naturelle, Ministère des Travaux Publics, Paris, France; Agricultural Experiment Stations, Burlington, Vt., Amherst, Mass., Buffalo, N. Y., Ithaca, N. Y., College Park, Md., Raleigh, N. C., Knoxville, Tenn., Agricultural College, Miss., Manhattan, Kans., Brookings, S. Dak.

Letters of acknowledgment were received from the Universetets-Bibliotheket, Christiania, Norway (144); R. Norwegian Society of Sciences, Throndhjem (144); K. Zoologisch-Botanisch Genootschap, The Hague, Holland (144); Royal Zoölogical Society (144), Royal Academy of Sciences, Amsterdam, Netherlands (140–142, and Trans., xvii, 3; viii, 1); Musée Teyler, Harlem, Holland (144); Maatschappij van Nederlandsche Letterkunde, Leiden, Holland (144); Anthropologische Gesellschaft (142, 144), K. K. Geologische Reichsanstalt (144), Dr. Aristides Brezina (142, 144), Prof. E. Suess, Vienna, Austria (142, 144); Verein für Geographie u. Statistik, Frankfurt-am-Main, Germany (140–142); Naturwissenschaftliche Verein des Reg. Bez. Frankfurt-an-der-Oder, Prussia

(142, 144); Società Africana d'Italia, Naples, Italy (144); Brown University, Providence, R. I. (144); Oregon Agricultural College, Corvallis (140, 145).

Accessions to the Library were reported from the Physikalisch-Technische Reichsanstalt, Messrs. Friedländer & Sohn, Berlin, Prussia; Schlesische Gesellschaft für vaterländische Cultur, Breslau, Prussia; Vogtländische Alterthumsforschende Verein, Hohenleuben, Saxony; Naturwissenschaftliche Verein, Regensburg, Bavaria; Marquis de Rochambeau, Vendome, France; Meteorological Office, London, England; Dr. Samuel A. Green, Boston, Mass.; Dr. J. C. Morris, Mr. Frederick Prime, Philadelphia; Rev. Prof. Frank P. Manhart, Selinsgrove, Pa.; U. S. Department of Agriculture, Washington, D. C.; Pullman's Palace Car Co, Chicago, Ill.; Lick Observatory, Mt. Hamilton; Prof. Dr. L. Harpérath, Buenos Ayres, S. A.; Agricultural Experiment Stations, Geneva, N. Y.; Charleston, W. Va., Columbus, O.

A cabinet photograph of Mr. W. W. Jefferis was presented by himself.

The President reported that he had appointed Messrs. Greene, Brinton and Phillips as the Committee on Collation after Meeting provided for in the resolution of November 2, 1894.

Owing to the absence of a constitutional quorum, action on the proposed amendments to the Laws was postponed until the next stated meeting of the Society.

Pending nominations Nos. 1273, 1274, 1276–1303 inclusive and new nomination No. 1304 were read.

Specimens of the Anaglyph, the latest discovery of Ducos Du Hauron, the French photo scientist, were shown by Mr. Julius F. Sachse. The subject was discussed by Dr. J. Cheston Morris, Prof. W. H. Greene, Dr. D. G. Brinton, Dr. George H. Horn and others.

Dr. Brinton moved that the President be authorized and empowered to appoint, at his leisure, a committee of five members to devise and report an improvement in the Laws respecting the election of members.

(The President subsequently appointed Messrs. Brinton, Prime, Morehouse, Greene and Cattell).

Dr. Morris moved to refer the resolution to Council with directions to report upon the same at the next meeting of the Society.

Dr. Morris' motion, being put to a vote, was lost.

The original motion then being put, was carried.

And the Society was adjourned by the President.

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*Stated Meeting, December 7, 1894.*

President, Mr. FRALEY, in the Chair.

Corresondence was submitted as follows:

Letters of envoy were received from the Institut Egyptien, Cairo; Australasian Association for Advancement of Science, Adelaide; Royal Society of New South Wales, Sydney, Australia; Verein für Schlesische Insektenkunde, Schlesische Gesellschaft für Vaterländische Cultur, Breslau, Prussia; Vogtländische Alterthumsforschende Verein, Hohenleuben, Saxony; M. de Nadaillac, Paris, France; Royal Observatory, Greenwich. England; Zoölogical and Statistical Societies, London, England; Dr. Isaac Roberts, Starfield, Crowborough, Sussex, England; Bureau of Statistics of Labor, Boston, Mass.; American Academy of Medicine, Easton, Pa.; Prof. J. P. Lesley, Philadelphia; Committee on Finance, U. S. Senate, U. S. Coast and Geodetic Survey, Washington. D.C.; Agricultural Experiment Stations, Lake City, Fla., New Orleans, La., College Station, Tex.; Fort Collins, Colo., St. Anthony Park, Minn., Tucson, Ariz.; Kansas Academy of Science, Topeka; Direccion General de Estadistica, Mexico, Mexico.

Accessions to the Library were reported from the Australasian Association for the Advancement of Science, Adelaide; Government Museum, Madras, India; K. P. Akademie der

Wissenschaften, Berlin, Prussia; Nassauische Verein für Naturkunde, Wiesbaden, Prussia; Biblioteca N. C. di Firenze, Italia; Marquis de Nadaillac, M. Levasseur, Paris, France; Meteorological Office, London, England; Dr. Isaac Roberts, Starfield, Crowborough, Sussex, England; Royal Observatory, Cape of Good Hope, Africa; H. G. Pearson Memorial Committee, New York; American Academy of Medicine, Easton, Pa.; Miss Elizabeth Harvey Morison, Philadelphia; Committee on Finance, Washington, D. C.; Public Library, Cincinnati, O.; Director of the Field Columbian Museum, Chicago, Ill.; Direccion General de Estadistica, Mexico, Mexico; Agricultural Experiment Stations, New Haven, Conn., Byran, Tex., Auburn, Ala.

Mr. Charles A. Rutter presented to the Cabinet, through Dr. J. C. Morris, photographs of the Mexican Sacrificial Stone and Mexican Calendar Stone.

Dr. Charles S. Dolley read an obituary notice of the late John M. Maisch.

The following deaths were announced:

Rev. James McCosh (Princeton, N. J.), November 16, 1894, æt. 83.

Hon. Robert C. Winthrop (Boston, Mass.), November 16, 1894, æt. 85.

The following amendments to the Laws laid over from the last meeting were considered and being put to a vote were carried unanimously, a constitutional quorum being present and voting.

Sections 9 and 10, Chapter I, were put to a vote and carried as follows:

"SECTION 9. Such members as reside within *thirty* miles of the hall of the Society, and such other members as desire to vote at the meetings and elections, shall pay an admission fee of ten dollars, and annually thereafter, on the first Friday of January, a contribution of five dollars. The payment of *one hundred dollars* at one time, by a member not in arrears, shall exempt him from all future annual payments.

"SECTION 10. Members-elect residing within thirty miles of the hall shall lose the right of membership unless they subscribe the Laws and pay their admission fee within one year after their election. Any member liable to an annual contribution, who shall neglect or refuse to pay the same for the term of two years, shall be notified by the Treasurer in

writing, on or before the second Friday in January after such default, that his rights as a member are suspended; and, in case the said arrears, together with the contribution due on the first Friday in January after such notice, shall not be paid to the Treasurer on or before the said last-named day, the membership of such defaulting member shall be forfeited, his name stricken from the roll, and reported to the Society by the Treasurer."

Chapter IX, Section 3, was amended and carried as follows:

"SECTION 3. *Twenty* qualified voters present at any stated or special meeting shall be a quorum, and be competent to elect members, dispose of property, appropriate money, and award premiums; but no property shall be alienated or encumbered, except by the vote of three-fourths of the qualified voters present, and given at two successive stated meetings. For the transaction of the ordinary business, the reception and reference of communications on literary, scientific or other subjects, the members present shall be deemed competent to act, and, in the absence of qualified voters, shall form a quorum."

Chapter VII, Section 7, was amended and carried as follows:

"SECTION 7. The President and Senior Secretary of the Society shall be, *ex-officio*, the President and Clerk at their meetings; and *seven* of their number shall be a quorum."

On motion the Committee was discharged.

The following report was presented from the Committee appointed November 16, 1894, to report a new method of electing members:

The Committee appointed by resolution of the Society dated November 16, to report desirable alterations in the By-Laws touching the election of members, recommend as follows:

That Sections 2, 3 and 4 of Chapter I of the Laws of the Society be repealed, and that in their place the following laws be substituted:

"2. A Standing Committee on Resident Membership shall be elected by the Society, on the third Friday in January, to consist of six members, the term of office of two of whom shall expire each year, and none of whom shall be eligible for immediate reëlection; the function of which Committee shall be to examine carefully the claims of each candidate offered for membership, and to which Committee all nominations for membership shall be sent, signed by at least three members of the Society, none of whom shall be members of the Committee on Nominations.

"3. That at the meeting of the Society previous to that assigned for the election of members, the Committee on Nominations shall report to the Society on all nominations which were received by it previous to its last meeting, reporting which candidates received an affirmative vote of at least four out of the six members of the Committee, and which candidates received less than that number; and this report shall be printed and sent,

under seal, to each resident member of the Society, at least one week before the evening of the election; provided, however, that said Committee, before reporting to the Society the names of any candidates who have received less than four affirmative votes, shall notify the proposers of such candidates, in order that their names may be withdrawn, if their proposers so desire.

"4. Nominations for non-resident membership shall be signed by at least three members of the Society who are not of Council, and sent in to the Board of Officers and Council, who shall recommend for election such as they deem desirable, and the election of such shall be in the same manner and at the same time as above specified for resident members."

And to add to Section 6, of Chapter I, these words:

"And any candidate shall be deemed duly chosen who shall have received in his favor a majority of the votes cast."

D. G. BRINTON, *Chairman*,
FREDERICK PRIME,
GEORGE R. MOREHOUSE,
W. C. CATTELL,
WILLIAM H. GREENE.

The same was ordered to be made the special order of business for the next meeting, notice thereof to be sent to the members.

The Committee on Dr. Cope's Paper reported favorably on its publication and was discharged.

The Committee on Collation reported, and was indefinitely continued.

Pending nominations Nos. 1273, 1274, 1276–1303 (inclusive) were read, new nomination 1304 was read, and the Society was adjourned by the President.

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*Stated Meeting, December 21, 1894.*

President, Mr. FRALEY, in the Chair.

Correspondence was submitted as follows:

A circular letter was received from the R. Accademia di Scienze Lettere ad Arti, Modena, Italy, announcing the prizes which have been awarded during 1893–94. Also one from

the same Society announcing the death of its Secretary, Cav. Avv. Pietro Bortolotti.

Letters of acknowledgment were received from the Royal Society of Northern Antiquities, Copenhagen, Denmark (144); Colonial Museum, Haarlem, Holland (144); Friesch Genootschap, Leeuwarden, Netherlands (144); Drs. Friedrich S. Krauss (142, 144), Friedrich Müller, Vienna, Austria (142, 144, 145); Naturforschende Gesellschaft des Osterlandes, Altenburg, Germany (142, 144); Naturforschende Gesellschaft, Bamberg, Bavaria (142, 144); K. Bibliothek (144), Redaction der *Naturwissenschaftliche Wochenschrift*, Berlin, Prussia (142, 144); Naturwissenschaftliche Verein, Bremen, Germany (145); K. Leopoldina Carolina Academie der Deutschen Naturforscher, Halle a. S., Prussia (144); Dr. Henri de Saussure, Geneva, Switzerland (144); R. Accademia dei Lincei, R. Comitato Geologico d'Italia, Rome, Italy (144); Société Linnéenne, Bordeaux, France (144); Faculté des Sciences, Marseilles, France (145); Bureau des Longitudes (142), Rédaction *Cosmos* (145), Mr. A. Des Cloizeaux (144), Profs. A. Daubree (144), E. Mascart (145), Marquis de Nadaillac, Paris, France (145); Mr. Samuel Timmins, Arley, Coventry, Eng. (145); University Library, Cambridge, Eng. (145); Royal Society, British Association, Zoölogical Society, R. Meteorological Society, R. Institution of Great Britain, R. Astronomical Society, R. Statistical Society, Linnean Society, Victoria Institute, Mr. Archibald Geikie, London, Eng. (145); Dr. Isaac Roberts, Starfield, Crowborough, Sussex, Eng. (145); Royal Society of Edinburgh, Prof. James Geikie, Edinburgh, Scotland (145); Lord Kelvin, Glasgow, Scotland (145); Royal Dublin Society, Dublin, Ireland (145); Nova Scotian Institute of Science, Halifax (138); American Antiquarian Society, Worcester, Mass. (145); Brown University, Providence, R. I. (144); Society Natural Sciences, Buffalo, N. Y. (144); Geological Society of America, Rochester, N. Y. (135, 140); Messrs. Robert P. Field, William W. Jefferis, Philadelphia (145); Mr. E. T. im Thurn, Georgetown, British Guiana (142, 144).

Accessions to the Library were reported from the R. Ministero della Instruzione Publica, Padova, Italia; R. Accademia di Scienze, Lettere ed Arti, Modena, Italy; Società Reale, Naples, Italy; R. Istituto Veneto di Scienze Lettere ed Arti, Venice, Italy; Marquis de Nadaillac, Paris, France; Yorkshire Geological and Polytechnic Society, Halifax, Eng.; Victoria Institute, London, Eng.; Radcliffe Observatory, Oxford, Eng.; John Hopkins University, Baltimore, Md.; Bureau of Ethnology, United States Geological Survey of the Rocky Mountain Region, Washington, D. C.; Secretaria di Fomento, Mexico, Mexico.

The following death was announced:

Prof. Paul Albrecht, Hamburg, Germany.

Mr. Rosengarten read a paper entitled "The Château de Rochambeau."

Publication Committee reported that it had ordered the publication of Dr. Cope's paper for the *Transactions*.

Pending nominations Nos. 1273, 1274, 1276–1303 (inclusive), and new nomination No. 1304 were read.

Owing to the absence of the quorum required by the Laws of the Society, the report of the Finance Committee was not acted upon, the appropriations were not passed, and candidates for membership were not balloted for.

And the Society was adjourned by the President.

# INDEX TO VOL. XXXIII.

### *Stated Meetings Held.*



### *New Members Elected.*

#### *February 16, 1894.*



### *Decease of Members.*



### *Obituary Notices Ordered.*

# LIST OF SURVIVING MEMBERS

OF THE

# AMERICAN PHILOSOPHICAL SOCIETY,

## HELD AT PHILADELPHIA

FOR

# PROMOTING USEFUL KNOWLEDGE.

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Corrected to January 4, 1895,

BY

HENRY PHILLIPS, JR.,

A Secretary of the Society.

*List of surviving Members of the American Philosophical Society, held at Philadelphia for Promoting Useful Knowledge.*

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The addresses here given so far as known are at the present time. Corrections of this list are respectfully solicited.

A name printed in *italics* indicates that the Society is uncertain as to whether such member is still living and desires information on the subject.

The Society will be happy to receive *photographs* (cabinet size preferred) of such of its members as have not already sent.

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## A

| | *Name.* | *Date of Election.* | *Present Address.* |
|---|---|---|---|
| 1687. | ABBÈ, CLEVELAND | July 21, 1871, | Army Weather Bureau, Washington, D. C. |
| 2170. | ABBOTT, CHARLES C. | Dec. 20, 1889, | Bristol, Pa. |
| 1463. | ABBOT, HENRY L. | April 18, 1862, | New York city, N. Y. |
| 1809. | ÅCKERMAN, RICHARD | July 21, 1876, | Stockholm, Sweden. |
| 1713. | ACLAND, HENRY W. | Jan'y 17, 1873, | Oxford, England. |
| 2128. | ADAM, LUCIEN | Dec. 17, 1886, | Rennes, France. |
| 2081. | ADAMS, H. B. | May 21, 1886, | Baltimore, Md. |
| 1381. | *Adamson, Rev. John C.* | July 13, 1856. | |
| 1779. | AGASSIZ, ALEXANDER | April 16, 1875, | Cambridge, Mass. |
| 1642. | AGASSIZ, ELIZABETH | Oct. 15, 1869, | " " |
| 1860. | ALISON, ROBERT H. | May 3, 1878, | Ardmore, Pa. |
| 1869. | ALLEN, JOEL ASAPH | Sept. 20, 1878, | New York, N. Y. |
| 1927. | AMES, CHARLES G. | Jan'y 21, 1881, | Boston, Mass. |
| 2064. | ANDERSON, GEORGE B. | Feb'y 19, 1886, | West Point, N. Y. |
| 2164. | ANGELL, JAMES B. | Oct. 18, 1889, | Ann Arbor, Mich. |
| 1122. | *Angelis, Pedro de.* | Jan'y 17, 1840, | *Buenos Ayres, S. A.* |
| 2224. | APPLETON, WILLIAM HYDE | May 19, 1893, | Swarthmore, Pa. |
| 2102. | ARGYLL, DUKE OF | May 21, 1886, | London, England. |
| 1761. | ARMSTRONG, WM. GEORGE | July 17, 1874, | Newcastle-on-Tyne, England. |
| 1996. | ASHHURST, JOHN | Jan'y 18, 1884, | Philadelphia. |
| 2012. | ASHHURST, RICHARD L. | April 18, 1884, | " |

## B

| Name. | Date of Election. | Present Address. |
|---|---|---|
| 1995. BACHE, R. MEADE | Jan'y 18, 1884, | Philadelphia. |
| 1832. BACHE, THOMAS HEWSON | Feb'y 2, 1877, | " |
| 1630. BAIRD, HENRY CAREY | Jan'y 15, 1869, | " |
| 1991. BAIRD, HENRY M. | Jan'y 18, 1884, | Yonkers, N. Y. |
| 2075. BAKER, WILLIAM S. | May 21, 1886, | Philadelphia. |
| 2191. BALL, ROBERT S. | May 15, 1891, | Dublin, Ireland. |
| 1936. BARBER, EDWIN ATLEE | April 15, 1881, | West Chester, Pa. |
| 1818. BARCENA, MARIANO | Feb'y 2, 1877, | Mexico. |
| 1741. BARKER, GEORGE F. | April 18, 1873, | Philadelphia. |
| 2011. BARKER, WHARTON | April 18, 1884, | " |
| 1902. BARTHOLOW, ROBERTS | April 16, 1880, | " |
| 1133. BARTLETT, W. H. C. | April 17, 1840, | Yonkers, N. Y. |
| 2119. BASTIAN, ADOLPH | Dec. 17, 1886, | Berlin, Germany. |
| 1968. BELL, ALEXANDER GRAHAM | July 21, 1882, | Washington. |
| 1966. BELL, JOSEPH SNOWDEN | July 21, 1882, | Philadelphia. |
| 1802. BELL, LOWTHIAN | April 21, 1876, | Northallerton, England. |
| 2228. BESSEMER, SIR HENRY | Feb'y 16, 1894, | Surrey, England. |
| 2149. BIDDLE, ALEXANDER | Feb'y 17, 1888, | Philadelphia. |
| 2154. BIDDLE, ARTHUR | Dec. 21, 1888, | " |
| 1920. BIDDLE, CADWALADER | Oct. 15, 1880, | " |
| 1831. BIDDLE, CRAIG | Feb'y 2, 1877, | " |
| 2134. BILLINGS, JOHN S. | Feb'y 18, 1887, | Washington, D. C. |
| 2157. BLAIR, ANDREW A. | May 17, 1889, | Philadelphia. |
| 1554. BLAIR, THOMAS S | Jan'y 19, 1866, | Tyrone, Pa. |
| 1669. BLAKE, WILLIAM PHIPPS | Oct. 21, 1870, | New Haven, Conn. |
| 1790. BLASIUS, WILLIAM | Oct. 15, 1875, | Philadelphia. |
| 1700. BLODGET, LORIN | April 19, 1872, | " |
| 1444. BÖHTLINGK, OTTO | Jan'y 17, 1862, | Leipzig, Germany. |
| 2047. BONWILL, W. G. A. | Oct. 16, 1885, | Philadelphia. |
| 1126. BOYÈ, MARTIN H. | Jan'y 17, 1840, | Coopersburg, Pa. |
| 1826. BRACKETT, CYRUS FOGG | Feb'y 2, 1877, | Princeton, N. J. |
| 2083. BRANNER, JOHN C. | May 21, 1886, | Stanford University, Cal. |
| 2195. BREZINA, ARISTIDES | May 21, 1886, | Vienna, Austria. |
| 1636. BRINTON, DANIEL G. | April 16, 1869, | Philadelphia. |
| 2069. BRINTON, JOHN H. | Feb'y 19, 1886, | " |
| 1745. BRITTON, J. BLODGETT | Oct. 17, 1873, | " |
| 2080. BROOKS, WILLIAM KEITH | May 21, 1886, | Baltimore, Md. |
| 1881. BROWN, ARTHUR ERWIN | April 18, 1879, | Philadelphia. |
| 1547. BRUSH, GEORGE J. | Jan'y 20, 1865, | New Haven, Conn. |
| 1653. BULLOCK, CHARLES | Oct. 15, 1869, | Philadelphia. |
| 1452. BUNSEN, ROBERT W. | Jan'y 17, 1862, | Heidelberg, Germany. |
| 2007. BURK, JESSE Y. | Jan'y 18, 1884, | " |
| 1938. BUTLER, WILLIAM | April 15, 1881, | West Chester, Pa. |

## C

| | | |
|---|---|---|
| 1788. CAMPBELL, JOHN LYLE | July 16, 1875, | Crawfordsville, Ind. |
| 1606. CANBY, WILLIAM MARRIATT | Oct. 16, 1868, | Wilmington, Del. |
| 2051. CANNIZZARO, TOMMASO | Oct. 16, 1885, | Messina, Italy. |
| 1731. CAPELLINI, GIOVANNI | April 18, 1873, | Bologna, Italy, |
| 1796. CARLL, J. F. | Oct. 15, 1875, | Pleasantville, Pa. |
| 2130. CARRILLO, CRESCENCIO | Dec. 17, 1886, | Merida, Yucatan. |
| 1911. CARSON, HAMPTON L. | April 16, 1880, | Philadelphia. |
| 1707. CASSATT, ALEXANDER JOHNSON | Oct. 18, 1872, | " |
| 2147. CASTNER, SAMUEL, JR. | Dec. 16, 1887, | " |

| Name. | Date of Election. | Present Address. |
|---|---|---|
| 2152. CATTELL, J. MCKEEN . . . . . . | May 18, 1888, | Garrison-on-Hudson, N. Y. |
| 1675. CATTELL, WILLIAM C. . . . . . . | Jan'y 20, 1871, | Philadelphia. |
| 1908. CHANCE, HENRY MARTYN . . . | April 16, 1880, | " |
| 1783. CHANDLER, C. F . . . . . . . . | April 16, 1875, | New York, N. Y. |
| 1778. CHAPMAN, HENRY C. . . . . . . | April 16, 1875, | Philadelphia. |
| 2132. CHARENCEY, COMTE HYACINTH DE | Dec. 17, 1886, | Paris, France. |
| 2158. CLARK, CLARENCE H. . . . . . . | May 17, 1889, | Philadelphia. |
| 1717. CLARKE, THOMAS C. . . . . . . | Jan'y 17, 1873, | New York, N. Y. |
| 1983. CLAYPOLE, E. W. . . . . . . . . | Jan'y 19, 1883, | Akron, Ohio. |
| 1876. CLOISEAUX, DES, A. . . . . . . . | Oct. 18, 1879, | Paris, France. |
| 1999. COHEN, J. SOLIS . . . . . . . . | Jan'y 18, 1884, | Philadelphia. |
| 1555. COPE, EDWARD D.. . . . . . . . | Jan'y 19, 1866, | " |
| 1367. COPPÉE, HENRY . . . . . . . . . | Jan'y 18, 1856, | Bethlehem, Pa. |
| 2129. CORA, GUIDO . . . . . . . . . . | Dec. 17, 1886, | Turin, Italy. |
| 1867. COUES, ELLIOTT . . . . . . . . . | Sept. 20, 1878, | Washington, D. C. |
| 1662. COX, J. D. . . . . . . . . . . . . | April 15, 1870, | Cincinnati, O. |
| 1672. COXE, ECKLEY B. . . . . . . . . | Oct. 21, 1870, | Drifton, Pa. |
| 2207. CRAMP, CHARLES H . . . . . . . | Dec. 16, 1892, | Philadelphia. |
| 1836. CRANE, THOMAS F. . . . . . . . | Feb'y 2, 1877, | Ithaca, N. Y. |
| 2100. CROOKES, WILLIAM . . . . . . . | May 21, 1886, | London, England. |
| 2172. CRUZ, FERNANDO (of Guatemala) | Dec. 20, 1889. | |
| 1439. CURWEN, JOHN . . . . . . . . . | April 18, 1861, | Warren, Pa. |

## D

| | | |
|---|---|---|
| 1567. DA COSTA, J. M. . . . . . . . . . | Oct. 19, 1866, | Philadelphia. |
| 2214. DALY, CHARLES P.. . . . . . . . | May 19, 1893, | New York, N. Y. |
| 1354. DANA, JAMES D . . . . . . . . | July 21, 1854, | New Haven, Conn. |
| 1806. DANNEFELD, C. JUHLIN . . . . . | April 21, 1876, | Stockholm, Sweden. |
| 1516. DAUBRÉE, A. . . . . . . . . . . | July 17, 1863, | Paris, France. |
| 1811. DAVENPORT, SAMUEL. . . . . . . | Oct. 20, 1876, | Adelaide, S. Australia. |
| 1557. DAVIDSON, GEORGE. . . . . . . . | Jan'y 19, 1866, | San Francisco, Cal. |
| 1923. DAWKINS, WILLIAM B . . . . . . | Oct. 15, 1880, | Manchester, England. |
| 1468. DAWSON, JOHN W . . . . . . . . | April 18, 1862, | Montreal, Canada. |
| 2131. DELGADO, JUAN DE DIAS DE LA RADA Y. . . . . . . . . . . | Dec. 17, 1886, | Madrid, Spain. |
| 2203. DERCUM, FRANCIS X. . . . . . . | Dec. 16, 1892, | Philadelphia. |
| 2013. DICKSON, SAMUEL . . . . . . . . | April 18, 1884, | " |
| 2208. DIXON, SAMUEL G.. . . . . . . . | Dec. 16, 1892, | " |
| 2108. DOLLEY, CHARLES S. . . . . . . | Dec. 17, 1886, | " |
| 2089. DONNER, OTTO. . . . . . . . . . | May 21, 1886, | Helsingfors, Finland. |
| 1946. DOOLITTLE, C. L. . . . . . . . | Oct. 21, 1881, | Bethlehem, Pa. |
| 1839. DOUGLASS, JAMES, JR. . . . . . . | April 20, 1877, | Spuytenduyvil, N. Y. |
| 1924. DRAPER, DANIEL . . . . . . . . | Oct. 15, 1880, | New York, N. Y. |
| 1787. DROWN, THOMAS M . . . . . . . | July 16, 1875, | Boston, Mass. |
| 1918. DU BOIS, PATTERSON . . . . . . | Oct. 15, 1880, | Philadelphia. |
| 1878. DUDLEY, CHARLES BENJAMIN . . | Jan'y 17, 1879, | Altoona, Pa. |
| 2063. DUNCAN, LOUIS . . . . . . . . . | Feb'y 19, 1886, | U. S. Navy. |
| 1573. DUNNING, GEORGE F. . . . . . . | Jan'y 18, 1867, | Farmington, Conn. |
| 1727. DUPONT, EDOUARD . . . . . . . | April 18, 1873, | Brussels, Belgium. |
| 2227. DUPONT, HENRY A. . . . . . . . | Feb'y 16, 1894, | Winterthur, Del. |
| 2086. DURUY, VICTOR . . . . . . . . | May 21, 1886, | Paris, France. |
| 1679. DUTTON, CLARENCE E . . . . . . | Jan'y 20, 1871, | Washington, D. C. |

## E

| | | |
|---|---|---|
| 2105. EASTON, MORTON W. . . . . . . | Dec. 17, 1886, | Philadelphia. |
| 1917. ECKFELDT, JACOB B . . . . . . . | Oct. 15, 1880, | " |

| Name. | Date of Election. | Present Address. |
|---|---|---|
| 1825. EDDY, HENRY T. . . . . . . . . | Feb'y 2, 1877, | Terre Haute, Ind. |
| 1686. ELIOT, CHARLES W. . . . . . . . | April 21, 1871, | Cambridge, Mass. |
| 1981. EMMONS, S. F. . . . . . . . . . . | Jan'y 19, 1883, | Washington, D. C. |
| 1943. EVANS, JOHN . . . . . . . . . | Oct. 21, 1881, | Hemel Hempstead, Eng. |
| | **F** | |
| 2180. FIELD, ROBERT PATTERSON . . . | May 16, 1890, | Philadelphia. |
| 1901. FLINT, AUSTIN, JR . . . . . . . . | April 16, 1880, | New York, N. Y. |
| 1621. FLOWER, WM. HENRY. . . . . . | Jan'y 15, 1869, | London, England. |
| 1875. FOGGO, EDWARD A. . . . . . . . | Oct. 18, 1879, | Philadelphia. |
| 2197. FORBES, GEORGE . . . . . . . . | Oct. 16, 1891, | London, England. |
| 1170. FRALEY, FREDERICK . . . . . . | July 15, 1842, | Philadelphia. |
| 1912. FRALEY, JOSEPH C. . . . . . . . | April 16, 1880, | " |
| 1695. FRAZER, PERSIFOR . . . . . . . | Jan'y 19, 1872, | " |
| 2171. FRIEBIS, GEORGE . . . . . . . . | Dec. 20, 1889, | " |
| 2179. FULLERTON, GEORGE S. . . . . . | May 16, 1890, | " |
| 1739. FULTON, JOHN. . . . . . . . . . | April 18, 1873, | Johnstown, Pa. |
| 1914. FURNESS, HORACE HOWARD . . . | April 16, 1880, | Philadelphia. |
| 1130. FURNESS, WILLIAM H. . . . . . . | April 17, 1840, | " |
| | **G** | |
| 1988. GARRETT, PHILIP C . . . . . . . | April 20, 1883, | Philadelphia. |
| 2079. GATES, M. E . . . . . . . . . . | May 21, 1886, | Amherst, Mass. |
| 1025. GATSCHET, ALBERT S. . . . . . . | Oct. 17, 1884, | Washington, D. C. |
| 1897. GEIKIE, ARCHIBALD . . . . . . . | Jan'y 16, 1880, | London, England. |
| 1803. GEIKIE, JAMES. . . . . . . . . . | April 21, 1876, | Edinburgh, Scotland. |
| 2067. GENTH, F. A., JR. . . . . . . . . | Feb'y 19, 1886, | Philadelphia, Pa. |
| 1355. GIBBS, OLIVER WOLCOTT. . . . . | July 21, 1854, | Cambridge, Mass. |
| 1587. GILL, THEODORE NICHOLAS . . | July 19, 1867, | Washington, D. C. |
| 1800. GILMAN, DANIEL C. . . . . . . | April 21, 1876, | Baltimore, Md. |
| 1940. *Giraldes, J. P. C. Cassado de.* . . | July 20, 1827. | |
| 1950. GLADSTONE, WM. EWART . . . . | Oct. 21, 1881, | London, England. |
| 2212. GOODALE, GEORGE LINCOLN . . . | Feb. 17, 1893, | Cambridge, Mass. |
| 2162. GOODE, G. BROWN . . . . . . . . | Oct. 18, 1889, | Washington, D. C. |
| 1680. GOODFELLOW, EDWARD. . . . . . | Jan'y 20, 1871, | " |
| 2203. GOODWIN, HAROLD . . . . . . . | May 20, 1892, | Philadelphia. |
| 1271. GOULD, BEN. APTHORP . . . . . . | Jan'y 17, 1851, | Cambridge, Mass. |
| 1851. GRAY, ELISHA. . . . . . . . . | Jan'y 18, 1878, | Chicago, Ill. |
| 2222. GREEN, SAMUEL A. . . . . . . . | Oct. 20, 1893, | Boston, Mass. |
| 1605. GREEN, TRAILL . . . . . . . . . | Oct. 16, 1868, | Easton, Pa. |
| 1504. GREEN, WILLIAM HENRY . . . . | April 17, 1863, | Princeton, N. J. |
| 1880. GREENE, WILLIAM H. . . . . . . | April 18, 1879, | Philadelphia. |
| 2155. GREGORIO, IL MARCHESE ANTONIO DE . . . . . . . . . . . . . | Dec. 21, 1888, | Palermo, Sicily. |
| 2159. GREGORY, HENRY D. . . . . . . | May 17, 1889, | Philadelphia. |
| 2188. GREGORY, CASPAR RÉNÉ. . . . . | May 15, 1891, | Leipzig. |
| 1229. *Grimaldi, Ceva* . . . . . . . . | Oct. 16, 1846, | *Naples, Italy.* |
| 1939. GRISCOM, WM. WOODNUTT . . . . | April 15, 1881, | Haverford, Pa. |
| 1815. GROTE, AUGUSTUS RADCLIFFE . . | Oct. 20, 1876. | |
| 2090. GUBERNATIS, ANGELO DE . . . . | May 21, 1886, | Florence, Italy. |
| 1438. GUYANGOS, PASCUAL DE. . . . . | April 19, 1861, | London, England. |
| | **H** | |
| 2054. HAECKEL, ERNEST. . . . . . . . | Oct. 16, 1885, | Jena, Prussia. |
| 1658. HALE, EDW. EVERETT . . . . . . | Jan'y 21, 1870, | Roxbury, Mass. |
| 1709. HALE, HORATIO . . . . . . . . . | Oct. 18, 1872, | Clinton, Canada. |

| Name. | Date of Election. | Present Address. |
|---|---|---|
| 1853. HALL, ASAPH | Jan'y 18, 1878, | Washington, D. C. |
| 1795. HALL, CHARLES EDWARD | Oct. 15, 1875, | Westport, N. Y. |
| 2219. HALL, ISAAC H | May 19, 1893, | New York, N. Y. |
| 1356. HALL, JAMES | July 21, 1854, | Albany, N. Y. |
| 2027. HALL, LYMAN B | Jan'y 16, 1885, | Haverford, Pa. |
| 1412. HAMMOND, WILLIAM A | Oct. 21, 1859, | New York, N. Y. |
| 2194. HAMY, E. T. | May 15, 1891, | Paris, France. |
| 1337. HARDING, GEORGE | Jan'y 20, 1854, | Philadelphia. |
| 2136. HARRIS, JOSEPH S. | May 20, 1887, | " |
| 1827. HART, JAMES MORGAN | Feb'y 2, 1877, | Ithaca, N. Y. |
| 1510. HARTSHORNE, HENRY | July 17, 1863, | Philadelphia. |
| 1764. HAUER, FRANZ RITTER VON | Oct. 16, 1874, | Vienna, Austria. |
| 1681. HAUPT, HERMANN | April 21, 1871, | St. Paul, Minn. |
| 1862. HAUPT, LEWIS M. | May 3, 1878, | Philadelphia. |
| 2082. HAYES, R. SOMERS | May 21, 1886, | New York, N.Y. |
| 2071. HAYS, J. MINIS | Feb'y 19, 1886, | Philadelphia. |
| 2165. HAZLEHURST, HENRY | Oct. 18, 1889, | " |
| 1985. HEILPRIN, ANGELO | April 20, 1883, | " |
| 2218. HEWETT, WATERMAN T. | May 19, 1893, | Ithaca, N. Y. |
| 1963. HILL, HAMILTON ANDREWS | April 21, 1882, | Boston, Mass. |
| 2110. HILPRECHT, HERMANN V. | Dec. 17, 1886, | Philadelphia. |
| 1768. HIMES, CHARLES FRANCIS | Oct. 16, 1874, | Carlisle, Pa. |
| 1663. HITCHCOCK, CHARLES HENRY | April 15, 1870, | Hanover, N. H. |
| 2160. HOFFMAN, WALTER J. | Oct. 18, 1889, | Washington, D. C. |
| 2068. HOLLAND, JAMES W. | Feb'y 19, 1886, | Philadelphia. |
| 1624. HOOKER, JOSEPH D. | Jan'y 15, 1869, | London, England. |
| 2221. HOPPIN, J. M | Oct. 20, 1893, | New Haven, Conn. |
| 1607. HORN, GEORGE HENRY | Oct. 16, 1868, | Philadelphia. |
| 2070. HORNER, INMAN | Feb'y 19, 1886, | " |
| 1941. HOTCHKISS, JEDEDIAH | Oct. 21, 1881, | Staunton, Va. |
| 1696. HOUGH, GEORGE W. | Jan'y 19, 1872, | Evanston, Ill. |
| 1698. HOUSTON, EDWIN J. | Jan'y 19, 1872, | Philadelphia. |
| 2143. HOUSTON, HENRY H | May 20, 1887, | " |
| 2084. HOVELACQUE, ABEL | May 21, 1886, | Paris, France. |
| 1843. HUMPHREY, H. C | July 20, 1877. | |
| 2211. HUMPHREY, JAMES ELLIS | Dec. 16, 1892, | Baltimore, Md. |
| 1623. HUXLEY, THOMAS HENRY | Jan'y 15, 1869, | London, England. |
| 1426. HYRTL, JOSEPH | July 20, 1860, | Vienna, Austria. |

## I

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|---|---|---|
| 2052. IM THURN, EVERARD F. | Oct. 16, 1885, | Georgetown, British Guiana. |
| 2221. D'INVILLIERS, EDWARD VINCENT | May 19, 1893, | Philadelphia. |
| 1773. INGHAM, WM. ARMSTRONG | April 16, 1875, | " |

## J

| | | |
|---|---|---|
| 2010. JAMES, EDMUND J. | April 18, 1884, | Philadelphia. |
| 1933. JANNET, CLAUDIO | April 15, 1881, | Paris, France. |
| 2049. JAYNE, HORACE | Oct. 16, 1885, | Philadelphia. |
| 1951. JEFFERIS, WILLIAM W | Jan'y 20, 1882, | " |
| 2017. JORDAN, FRANCIS, JR. | April 18, 1884, | " |

## K

| | | |
|---|---|---|
| 1989. KANE, ELISHA KENT | April 20, 1883, | Kane, Pa. |
| 2169. KEANE, JOHN J. | Dec. 20, 1889, | Washington, D. C. |
| 2021. KEEN, WILLIAM W. | July 18, 1884, | Philadelphia. |

| Name. | Date of Election. | Present Address. |
|---|---|---|
| 1723. KELVIN, LORD (WM. THOMSON). . | April 18, 1873, | London, England. |
| 2118. KIEPERT, HENRI . . . . . . . . | Dec. 17, 1886, | Berlin, Prussia. |
| 1161. KENDALL, E. OTIS . . . . . . . . | Jan'y 21, 1842, | Philadelphia. |
| 1708. KING, CLARENCE . . . . . . . . | Oct. 18, 1872, | New York, N. Y. |
| 1284. KIRKWOOD, DANIEL . . . . . . . | April 18, 1851, | Riverside, Cal. |
| 1767. KÖNIG, GEORGE A . . . . . . . . | Oct. 16, 1874, | Houghton, Mich. |
| 2167. KRAUSS, FRIEDERICH S . . . . . | Dec. 20, 1889, | Vienna, Austria. |

## L

| | | |
|---|---|---|
| 1694. LAMBERT, GUILLAUME. . . . . . | Jan'y 19, 1872, | Louvain, Belgium. |
| 1858. LANDRETH, BURNET. . . . . . . | Jan'y 18, 1878, | Bristol, Pa. |
| 1781. LANGLEY, SAMUEL P. . . . . . . | April 16, 1875, | Washington, D. C. |
| 1721. LA ROCHE, C. PERCY . . . . . . | Jan'y 17, 1873, | Philadelphia. |
| 1711. LAUTH, FRANZ JOSEPH . . . . . | Oct. 18, 1872, | Munich, Bavaria. |
| 1974. LAWES, JOHN BENNETT . . . . . | Jan'y 19, 1883, | Rothamstead, Herts, Eng. |
| 1595. LEA, HENRY CHARLES. . . . . . | Oct. 18, 1867, | Philadelphia. |
| 1737. LE CONTE, JOSEPH. . . . . . . . | April 18, 1873, | Berkeley, Cal. |
| 1986. LEHMAN, AMBROSE E. . . . . . . | April 20, 1883, | Philadelphia. |
| 2182. LELAND, CHARLES G. . . . . . . | May 16, 1890, | London, Eng. |
| 2174. LE MOINE, J. M. . . . . . . . . . | Dec. 20, 1889, | Quebec, Canada. |
| 1934. LE ROY-BEAULIEU, PAUL. . . . . | April 15, 1881, | Paris, France. |
| 1382. LESLEY, J. PETER . . . . . . . . | July 13, 1856, | Philadelphia. |
| 1376. LETCHWORTH, ALBERT S. . . . . | Jan'y 18, 1856, | " |
| 2085. LEVASSEUR, EMILE. . . . . . . . | May 21, 1886, | Paris, France. |
| 1415. LEWIS, FRANCIS W. . . . . . . . | Jan'y 20, 1860, | Philadelphia. |
| 1756. LOCKYER, JOSEPH NORMAN. . . . | April 17, 1874, | London, England. |
| 2202. LOW, SETH . . . . . . . . . . . | Feb. 19, 1892, | New York, N. Y. |
| 1872. LONGSTRETH, MORRIS . . . . . . | Sept. 20, 1878, | Philadelphia. |
| 2019. LUBBOCK, JOHN . . . . . . . . . | July 18, 1884, | London, England. |
| 2003. LUDLOW, WILLIAM. . . . . . . . | Jan'y 18, 1884, | U. S. A. |
| 1629. LYMAN, BENJAMIN SMITH . . . . | Jan'y 15, 1869, | Philadelphia. |

## M

| | | |
|---|---|---|
| 2107. MACALISTER, JAMES . . . . . . . | Dec. 17, 1886, | Philadelphia. |
| 2209. MACFARLANE, JOHN M. . . . . . | Dec. 16, 1892, | Lansdowne, Pa. |
| 2042. MALLET, JOHN WM. . . . . . . . | Jan'y 16, 1885, | University of Virginia, Va. |
| 1847. MANSFIELD, IRA FRANKLIN . . . | Jan'y 18, 1878, | Cannelton, Pa. |
| 1857. MARCH, FRANCIS ANDREW . . . | Jan'y 18, 1878, | Easton, Pa. |
| 1861. MARKS, WILLIAM D . . . . . . . | May 3, 1878, | Philadelphia. |
| 1604. MARSH, OTHNIEL C . . . . . . . | Oct. 16, 1868, | New Haven, Conn. |
| 2078. MARSHALL, JOHN . . . . . . . . | May 21, 1886, | Philadelphia. |
| 1018. *Martinez, Juan José* . . . . . . . | April 20, 1832, | *Spain.* |
| 2184. MASCART, E.. . . . . . . . . . . | Dec. 19, 1890, | Paris, France. |
| 1572. MASON, ANDREW . . . . . . . . | Jan'y 18, 1867, | New York, N. Y. |
| 2196. MASPERO, GASTON . . . . . . . . | May 15, 1891, | Paris, France. |
| 1654. MAYER, ALFRED M . . . . . . . | Oct. 15, 1869, | Hoboken, N. J. |
| 1888. MCCREATH, ANDREW S. . . . . . | July 18, 1879, | Harrisburg, Pa. |
| 1821. MCKEAN, WILLIAM V. . . . . . . | Feb'y 2, 1877, | Philadelphia. |
| 2004. MCMASTER, JOHN BACH . . . . . | Jan'y 18, 1884, | " |
| 1677. MEEHAN, THOMAS . . . . . . . . | Jan'y 20, 1871, | " |
| 1903. MERRICK, JOHN VAUGHAN . . . | April 16, 1880, | " |
| 1947. MERRIMAN, MANSFIELD . . . . . | Oct. 21, 1881, | Bethlehem, Pa. |
| 1744. MESSCHERT, MATHEW HUIZINGA. | Oct. 17, 1873, | Douglassville, Pa. |

| Name. | Date of Election. | Present Address. |
|---|---|---|
| 2142. MICHAEL, HELEN ABBOTT. . . . | May 20, 1887, | Philadelphia. |
| 2175. MITCHELL, JAMES T. . . . . . . . | Feb'y 21, 1890, | " |
| 1461. MITCHELL, S. WEIR . . . . . . . | Jan'y 17, 1862, | " |
| 2114. MONIER-WILLIAMS, MONIER . . . | Dec. 17, 1886, | London, England. |
| 1791. MOORE, GIDEON E . . . . . . . . | Oct. 15, 1875, | New York, N. Y. |
| 2029. MOORE, JAMES W . . . . . . . . | Jan'y 16, 1885, | Easton, Pa. |
| 1841. MOREHOUSE, GEORGE R . . . . . | April 20, 1877, | Philadelphia. |
| 1054. *Morelli*. . . . . . . . . . . . . . | Jan'y 15, 1836, | *Naples, Italy.* |
| 1976. MORRIS, J. CHESTON. . . . . . . | Jan'y 19, 1883, | Philadelphia. |
| 2223. MORRIS, JOHN G. . . . . . . . . . | Oct. 20, 1893, | Baltimore, Md. |
| 1577. MORTON, HENRY . . . . . . . . | Jan'y 18, 1867, | Hoboken, N. J. |
| 2121. MUCH, MATTHÆUS. . . . . . . . . | Dec. 17, 1886, | Vienna, Austria. |
| 1866. MUHLENBERG, F. A. . . . . . . . | Sept. 20, 1878, | Reading, Pa. |
| 2120. MUELLER, FRIEDERICH . . . . . | Dec. 17, 1886, | Vienna, Austria. |
| 1486. MUELLER, F. MAX. . . . . . . . . | Jan'y 16, 1863, | Oxford, England. |
| 2192. MUNROE, CHARLES E. . . . . . . | May 15, 1891, | Washington, D. C. |
| 2062. MURDOCK, J. B. . . . . . . . . . . | Feb'y 19, 1886, | U. S. Navy. |
| 1937. MURRAY, JAMES A. H. . . . . . | April 15, 1881, | Oxford, England. |

## N

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| 2087. NADAILLAC, MARQUIS DE. . . . . | May 21, 1886, | Paris, France. |
| 1852. NEWCOMB, SIMON . . . . . . . . | Jan'y 18, 1878, | Washington, D. C. |
| 1582. NEWTON, HUBERT ANSON . . . . | April 19, 1869, | New Haven, Conn. |
| 1703. NICHOLS, STARR HOYT . . . . | July 19, 1872, | New York, N. Y. |
| 2060. NIKITIN, SERGE . . . . . . . . . | Feb'y 19, 1866, | St. Petersburg, Russia. |
| 1805. NORDENSKIOLD, ADOLF ERIC . . | April 21, 1876, | Stockholm, Sweden. |
| 1712. NORRIS, ISAAC. . . . . . . . . | Oct. 18, 1872, | Philadelphia. |
| 2106. NORRIS, WILLIAM F. . . . . . . | Dec. 17, 1886, | " |
| 2046. NORTH, EDWARD. . . . . . . . . | Oct. 16, 1885, | Clinton, N. Y. |

## O

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|---|---|---|
| 2072. OLIVER, CHARLES A. . . . . . . . | Feb'y 19, 1886, | Philadelphia. |
| 1715. OLIVER, JAMES E. . . . . . . . . | Jan'y 17, 1873, | Ithaca, N. Y. |
| 2195. OPPERT, JULES. . . . . . . . . . | May 15, 1891, | Paris, France. |
| 2135. OSBORN, HENRY F. . . . . . . . | Feb'y 18, 1887, | New York, N. Y. |
| 2039. OSLER, WILLIAM . . . . . . . . . | Jan'y 16, 1885, | Baltimore, Md. |

## P

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|---|---|---|
| 1868. PACKARD, A. S., JR. . . . . . . . | Sept. 20, 1878, | Providence, R. I. |
| 1578. PACKARD, JOHN H. . . . . . . . | Jan'y 18, 1867, | Philadelphia. |
| 1331. PAGET, JAMES . . . . . . . . . . | Jan'y 20, 1854, | London, England. |
| 1984. PANCOAST, WILLIAM HENRY . . . | Jan'y 19, 1883, | Philadelphia. |
| 2036. PARVIN, THEOPHILUS . . . . . . | Jan'y 16, 1885, | " |
| 2056. PASTEUR, LOUIS . . . . . . . . . | Oct. 16, 1885, | Paris, France. |
| 2035. PATTERSON, C. STUART. . . . . . | Jan'y 16, 1885, | Philadelphia. |
| 1282. PATTERSON, ROBERT . . . . . . . | April 18, 1851, | " |
| 1320. PATTERSON, THOMAS L. . . . . . | April 15, 1853, | Cumberland, Md. |
| 2213. PATTISON, ROBERT E. . . . . . . | Feb. 17, 1893, | Harrisburg, Pa. |
| 1772. PEARSE, JOHN B. . . . . . . . . | Jan'y 15, 1875, | *Boston, Mass.* |
| 1859. PEIRCE, C. NEWLIN . . . . . . . | May 3, 1878. | Philadelphia. |
| 1722. PEMBERTON, HENRY. . . . . . . . | Jan'y 17, 1873, | " |
| 2104. PEÑAFIEL, ANTONIO . . . . . . . | May 21, 1886, | Mexico. |
| 2073. PENNYPACKER, SAMUEL W. . . | May 21, 1886, | Philadelphia. |
| 1518. PENROSE, R. A. F. . . . . . . . . | July 17, 1863, | " |

| Name. | Date of Election. | Present Address. |
|---|---|---|
| 2059. PEPPER, EDWARD . . . . . . . . . | Feb'y 19, 1886, | Paris. |
| 1666. PEPPER, WILLIAM . . . . . . . . | July 15, 1870, | Philadelphia. |
| 951. *Pereira, José Maria Dantes* . . . . | April 18, 1828, | *Lisbon, Portugal.* |
| 1824. PHILLIPS, HENRY, JR. . . . . . . | Feb'y 2, 1877, | Philadelphia. |
| 1760. PLATT, FRANKLIN . . . . . . . . | July 17, 1874, | " |
| 2127. PLATZMAN, JULIUS . . . . . . . . | Dec. 17, 1886, | Leipzig, Germany. |
| 2058. POMIALOWSKY, JOHN . . . . . . . | Oct. 16, 1885, | St. Petersburg, Russia. |
| 1589. PORTER, THOMAS CONRAD . . . . | Oct. 21, 1864, | Easton, Pa. |
| 2044. POTTS, WILLIAM JOHN . . . . . | Oct. 16, 1885, | Camden, N. J. |
| 2097. POSTGATE, J. P . . . . . . . . . | May 21, 1886, | Cambridge, England. |
| 2161. POWELL, J. W. . . . . . . . . . | Oct. 18, 1889, | Washington, D. C. |
| 1619. PRESTWICH, JOSEPH . . . . . . . | Jan'y 15, 1869, | Shoreham, England. |
| 1592. PRICE, J. SERGEANT . . . . . . . | Oct. 18, 1867, | Philadelphia. |
| 1780. PRIME, FREDERICK, JR . . . . . | April 16, 1875, | " |
| 2088. PULZSKY, FRANCIS . . . . . . . | May 21, 1886, | Buda-Pesth, Hungary. |
| 1758. PUMPELLY, RAPHAEL . . . . . . | April 17, 1874, | Newport, R. I. |

## R

| Name. | Date of Election. | Present Address. |
|---|---|---|
| 1736. RAND, THEODORE D. . . . . . . | April 18, 1873, | Philadelphia. |
| 1849. RANDALL, F. A. . . . . . . . . . | Jan'y 18, 1878, | Warren, Pa. |
| 1644. RAWLINSON, GEORGE. . . . . | Oct. 15, 1869, | Oxford, England. |
| 1765. RAWSON, RAWSON W . . . . . . | Oct. 16, 1874, | London, " |
| 2099. RAYLEIGH, LORD . . . . . . . . | May 21, 1886, | Essex, England. |
| 1781. RAYMOND, ROSSITTER W . . . . | April 16, 1875, | New York, N. Y. |
| 1585. RAYNOLDS, WILLIAM F. . . . . . | April 19, 1867, | Detroit, Mich. |
| 1591. READ, JOHN MEREDITH . . . . . | July 19, 1867. | |
| 2077. REED, HENRY . . . . . . . . . . | May 21, 1886, | Philadelphia. |
| 1889. REMSEN, IRA . . . . . . . . . . | July 18, 1879, | Baltimore, Md. |
| 1948. RENARD, A . . . . . . . . . . | Oct. 21, 1881, | Brussels, Belgium. |
| 1343. RENARD, CHARLES . . . . . . . | Jan'y 20, 1854, | Moscow, Russia. |
| 1890. RENEVIER, E. . . . . . . . . . . | July 18, 1879, | Lausanne, Switzerland. |
| 1816. REULEAUX, F . . . . . . . . . . | Feb'y 2, 1877, | Berlin, Prussia. |
| 2122. RÉVILLE, ALBERT . . . . . . . . | Dec. 17, 1886, | Paris, France. |
| 1500. RICHARDSON, BEN. WARD . . . | April 17, 1863, | London, England. |
| 1808. RILEY, CHARLES V . . . . . . . | April 21, 1876, | Washington, D. C. |
| 2226. ROBERTS, ISAAC . . . . . . . . . | Oct. 20, 1893, | Starfield, Crowborough, Sussex, England. |
| 1957. ROBINS, JAMES W. . . . . . . . | April 21, 1882, | Philadelphia. |
| 1390. ROGERS, FAIRMAN. . . . . . . . | Jan'y 16, 1857, | Newport, R. I. |
| 2177. ROGERS, ROBERT W . . . . . . . | Feb'y 21, 1890, | Madison, N. J. |
| 1462. RÖHRIG, F. L. O.. . . . . . . . . | April 18, 1862, | Los Angeles, Cal. |
| 2050. ROLLETT, HERMANN. . . . . . . | Oct. 16, 1885, | Vienna, Austria. |
| 1907. ROOD, OGDEN N. . . . . . . . . . | April 16, 1880, | New York, N. Y. |
| 1964. ROSNY, DE, LÉON . . . . . . . . | July 21, 1882, | Paris, France. |
| 1732. ROSSI, GIOVANNI BATTISTA. . . . | April 18, 1873, | Rome, Italy. |
| 2198. ROSENGARTEN, JOSEPH G. . . . . | Oct. 16, 1891, | Philadelphia. |
| 1718. ROTHERMEL, PETER F. . . . . . | Jan'y 17, 1873, | Linfield, Pa. |
| 1838. ROTHROCK, JOSEPH T . . . . . . | April 20, 1877, | Philadelphia. |
| 1264. RUSCHENBERGER, W. S. W. . . . | Oct. 19, 1849, | " |
| 1620. RUTIMEYER, CARL L. . . . . . . | Jan'y 15, 1869, | Basel, Switzerland. |
| 2109. RYDER, JOHN A . . . . . . . . . | Dec. 17, 1886, | Philadelphia. |

## S

| Name. | Date of Election. | Present Address. |
|---|---|---|
| 2230. SACHSE, JULIUS F . . . . . . . . | Feb'y 16, 1894, | Philadelphia. |
| 1766. SADTLER, SAMUEL PHILIP . . . . | Oct. 16, 1874, | " |
| 2148. SAJOUS, CHARLES E. . . . . . . . | Feb'y 17, 1888, | Paris, France. |

| Name. | Date of Election. | Present Address. |
|---|---|---|
| 1563. SANDBERGER, FRIDOLIN . . . . . | April 20, 1866, | Würtzburg, Bavaria. |
| 1958. SARGENT, CHARLES SPRAGUE . . | April 21, 1882, | Brookline, Mass. |
| 1730. SAUSSURE, HENRI DE. . . . . . . | April 18, 1873, | Geneva, Switzerland. |
| 2211. SCHAFFER, CHARLES . . . . . . . | Feb'y 17, 1893, | Philadelphia. |
| 1498. SCHOTT, CHARLES ANTHONY . . . | April 17, 1863, | Washington, D. C. |
| 1864. SCHURZ, CARL . . . . . . . . . . | Sept. 20, 1878. | |
| 1725. SCLATER, PHILLIP LUTLEY. . . . | April 18, 1873, | London, England. |
| 1919. SCOTT, LEWIS A. . . . . . . . . . | Oct. 15, 1880, | Philadelphia. |
| 2112. SCOTT, W. B. . . . . . . . . . . | Dec. 17, 1886, | Princeton, N. J. |
| 1870. SCUDDER, SAMUEL HUBBARD. . . | Sept. 20, 1878, | Cambridge, Mass. |
| 1883. SEILER, CARL . . . . . . . . . . | April 18, 1879, | Philadelphia. |
| 1704. SELLERS, COLEMAN . . . . . . . | July 19, 1872, | " |
| 1533. SELLERS, WILLIAM. . . . . . . . | April 15, 1864, | " |
| 1770. SELWYN, ALFRED R. C. . . . . . | Oct. 16, 1874, | Montreal, Canada. |
| 1728. SELYS, DE, LONGCHAMPS. . . . . | April 18, 1873, | Liége, Belgium. |
| 2057. SERGI, GIUSEPPE . . . . . . . . | Oct. 16, 1885, | Rome, Italy. |
| 1965. SÈVE DE BAR, EDOUARD . . . . . | July 21, 1882, | Ramsgate, England. |
| 2076. SHARP, BENJAMIN. . . . . . . . | May 21, 1886, | Philadelphia. |
| 1944. SHARPLES, PHILIP PRICE . . . . | Oct. 21, 1881, | West Chester, Pa. |
| 1960. SHARPLES, STEPHEN PASCHALL. . | April 21, 1882, | Boston, Mass. |
| 1797. SHERWOOD, ANDREW . . . . . . | Oct. 15, 1875, | Mansfield, Pa. |
| 1822. SHIELDS, CHARLES W. . . . . . . | Feb'y 2, 1877, | Princeton, N. J. |
| 1532. *Shinz, Carl*. . . . . . . . . . . . | April 15, 1864; | *Strasburg, Germany.* (?) |
| 2146. SMITH, EDGAR F. . . . . . . . . | Oct. 21, 1887, | Philadelphia. |
| 1544. SMITH, GOLDWIN. . . . . . . . . | Jan'y 20, 1865. | |
| 1789. SMITH, STEPHEN . . . . . . . . . | Oct. 15, 1875, | New York, N. Y. |
| 2141. SMYTH, ALBERT H. . . . . . . . | May 20, 1887, | Philadelphia. |
| 1742. SNOWDEN, A. LOUDON . . . . . . | Oct. 17, 1873, | " |
| 2009. SNYDER, MONROE B . . . . . . | Jan'y 18, 1884, | " |
| 2189. SPANGLER, HENRY W . . . . . . | May 15, 1891, | " |
| 1720. SPOFFORD, A. R. . . . . . . . . . | Jan'y 17, 1873, | Washington, D. C. |
| 1949. STALLO, JOHN B.. . . . . . . . . | Oct. 21, 1881, | Cincinnati, O. |
| 1446. STEENSTRUP, J. J. S. . . . . . . . | Jan'y 17, 1862, | Copenhagen, Denmark. |
| 1990. STEVENS, WALTER LECONTE . . . | Jan'y 18, 1884, | Troy, N. Y. |
| 1840. STEVENSON, JOHN JAMES. . . . . | April 20, 1877, | New York, N. Y. |
| 2168. STOKES, GEORGE G. . . . . . . . | Dec. 20, 1889, | London, England. |
| 1559. STRONG, WILLIAM . . . . . . . . | Jan'y 19, 1866, | Washington, D. C. |
| 1820. STUART, GEORGE. . . . . . . . . | Feb'y 2, 1877, | Philadelphia. |
| 2193. STUBBS, WILLIAM . . . . . . . . | May 15, 1891, | Oxford, England. |
| 2094. SUESS, EDWARD . . . . . . . . . | May 21, 1886, | Vienna, Austria. |
| 2023. SYLE, E. W. . . . . . . . . . . . | July 18, 1884, | Philadelphia. |
| 1844. SYLVESTER, J. J.. . . . . . . . . | July 20, 1877, | Oxford, England. |
| 2092. SZOMBATHY, JOSEF. . . . . . . . | May 21, 1886, | Vienna, Austria. |

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| 1786. TATHAM, WILLIAM P. . . . . . . | April 16, 1875, | Philadelphia. |
| 1846. TAYLOR, WILLIAM B. . . . . . . | Oct. 19, 1877, | Washington, D. C. |
| 2098. TEMPLE, RICHARD CARNAC . . . | May 21, 1886, | Upper Burmah, India. |
| 2006. THOMAS, ALLEN C.. . . . . . . . | Jan'y 18, 1884, | Haverford, Pa. |
| 1993. THOMPSON, HEBER S. . . . . . . | Jan'y 18, 1884, | Pottsville, Pa. |
| 1726. THOMPSON, HENRY. . . . . . . . | April 18, 1873, | London, England. |
| 1807. THOMSON, ELIHU . . . . . . . . | April 21, 1876, | Swampscott, Mass. |
| 1754. THOMSON, FRANK . . . . . . . . | April 17, 1874, | Philadelphia. |
| 1723. THOMSON, WILLIAM (see LORD KELVIN) . . . . . . . . . . | April 18, 1873, | London, England. |
| 1909. THOMSON, WILLIAM . . . . . . . | April 16, 1880, | Philadelphia. |

| Name. | Date of Election. | Present Address. |
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| 1530. THURY, A. . . . . . . . . . . . . | April 15, 1864, | Geneva, Switzerland. |
| 1638. TILGHMAN, BENJAMIN C . . . . . | July 21, 1871, | Philadelphia. |
| 1233. TILGHMAN, RICHARD A . . . . . | April 16, 1847, | " |
| 1657. TILGHMAN, WILLIAM M. . . . . . | Jan'y 21, 1870, | " |
| 2176. TIMMINS, SAMUEL . . . . . . . . | Feb. 21, 1890, | Arley, near Coventry, Eng. |
| 2123. TOPINARD, PAUL. . . . . . . . . | Dec. 17, 1886, | Paris, France. |
| 2065. TOPPAN, ROBERT NOXON. . . . . | Feb'y 19, 1886, | Cambridge, Mass. |
| 1597. TOWNSEND, JOSEPH B . . . . . . | Jan'y 17, 1868. | Philadelphia. |
| 2024. TRUMBULL, HENRY CLAY . . . . | July 18, 1884, | " |
| 1973. TSCHERMAK, GUSTAF . . . . . . | Oct. 20, 1882, | Vienna, Austria. |
| 1983. TURRETTINI, THEODORE . . . . . | Dec. 19, 1890, | Geneva, Switzerland. |
| 2166. TUTTLE, DAVID K . . . . . . . . | Oct. 18, 1889, | Philadelphia. |
| 2163. TYLER, LYON G . . . . . . . . . . | Oct. 18, 1889, | Williamsburg, Va. |
| 1529. TUNNER, PETER . . . . . . . . . | April 15, 1864, | Leoben, Austria. |
| 2136. TYSON, JAMES . . . . . . . . . . | May 20, 1887, | Philadelphia. |

## U

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| 2185. UNWIN, WILLIAM C . . . . . . . | Dec. 19, 1890, | London, England. |

## V

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| 2000. VAUX, RICHARD. . . . . . . . . | Jan'y 18, 1884, | Philadelphia. |
| 2045. VERE, DE, SCHEELE M. . . . . . | Oct. 16, 1885, | University of Virginia, Va. |
| 1475. VIRCHOW, RUDOLPH. . . . . . . | Oct. 17, 1862, | Berlin, Prussia. |
| 1646. VOGT, CARL . . . . . . . . . . . | Oct. 15, 1869, | Geneva, Switzerland. |
| 2115. VON MELTZEL, HUGO . . . . . . | Dec. 17, 1886, | Koloszvar, Hungary. |
| 1670. VOSE, GEORGE LEONARD. . . . . | Oct. 21, 1870, | Boston, Mass. |
| 2186. VOSSION, LOUIS . . . . . . . . . | Dec. 19, 1890, | Philadelphia. |

## W

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| 2034. WAGNER, SAMUEL . . . . . . . . | Jan'y 16, 1885, | Philadelphia. |
| 1748. WAHL, WILLIAM H. . . . . . . | Jan'y 16, 1874, | " |
| 1724. WALLACE, ALFRED R . . . . . . | April 18, 1873, | Parkston, Dorset, England. |
| 2156. WARD, LESTER F. . . . . . . . . | May 17, 1889, | Washington, D. C. |
| 2033. WEIL, EDWARD HENRY . . . . . | Jan'y 16, 1885, | Philadelphia. |
| 2028. WEISBACH, ALBIN . . . . . . . . | Jan'y 16, 1885, | Freiburg, Saxony. |
| 1639. WHARTON. JOSEPH. . . . . . . . | April 16, 1869, | Philadelphia. |
| 1637. WHITE, ANDREW D. . . . . . . . | April 16, 1869, | Ithaca, N. Y. |
| 1848. WHITE, ISRAEL C. . . . . . . . . | Jan'y 18, 1878, | Morgantown, W. Va. |
| 1487. WHITNEY, JOSIAH DWIGHT. . . . | Jan'y 16, 1863, | Cambridge, Mass. |
| 1863. WILDER, BURT GREEN . . . . . . | May 3, 1878, | Ithaca, N. Y. |
| 2151. WILLIAMS, TALCOTT . . . . . . . | May 18, 1888, | Philadelphia. |
| 2178. WILLIS, HENRY . . . . . . . . . | Feb'y 21, 1890, | " |
| 2150. WILSON, EDMUND B . . . . . . | Feb'y 17, 1888, | Bryn Mawr, Pa. |
| 2041. WILSON, JAMES CORNELIUS. . . . | Jan'y 16, 1885, | Philadelphia. |
| 1747. WILSON, JOSEPH M. . . . . . . . | Jan'y 16, 1874, | " |
| 2137. WILSON, WILLIAM POWELL . . . | May 20, 1887, | " |
| 2223. WINSOR, JUSTIN . . . . . . . . . | May 19, 1893, | Cambridge, Mass. |
| 2140. WIREMAN, HENRY D. . . . . . . | May 20, 1887, | Philadelphia. |
| 2220. WISTAR, ISAAC J. . . . . . . . . | May 19, 1893, | " |
| 1561. WISTER, OWEN JONES . . . . . . | April 20, 1866, | " |
| 1884. WOOD, RICHARD. . . . . . . . . | April 18, 1879, | " |
| 1762. WOODWARD, HENRY. . . . . . . | July 17, 1874, | London, England. |
| 1751. WOOTTEN, J. E. . . . . . . . . . | Jan'y 16, 1874, | Reading, Pa. |
| 1854. WORMLEY, THEODORE G. . . . . | Jan'y 18, 1878, | Philadelphia. |